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THOMAS EDISON
SAMUEL MORSE

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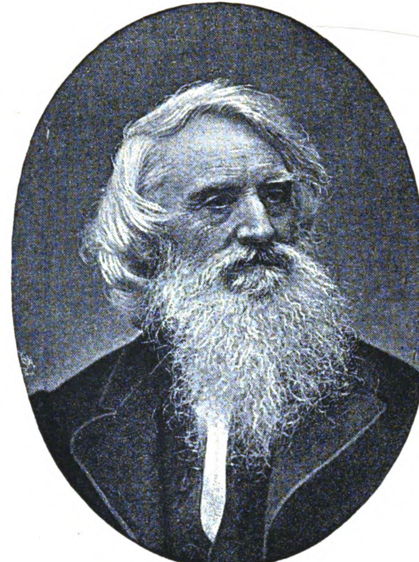
Thomas A Edison



Sam' F. B. Morse

THE WORLD'S WORKERS

F.D

Thomas A. Edison

AND

Samuel F. B. Morse

BY

VAN BUREN DENSLOW I.L.D.

Author of "Modern Thinkers," &c.

AND

JANE MARSH PARKER

Author of "Rochester: A Story Historical," &c.

SIXTH THOUSAND

CASSELL AND COMPANY LIMITED

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THOMAS ALVA EDISON.

SAMUEL FINLEY BREESE MORSE.

THOMAS ALVA EDISON.

CHAPTER I.

CHILDHOOD.

FOREMOST and most practical among the pioneers who are pressing outward on the confines of the knowable, and are seeking to make the most inscrutable forces tributary to human weal, is Thomas Alva Edison.

As inventor of the quadruplex system of telegraphy, whereby four separate and distinct messages, two in each direction, may pass simultaneously over a single wire, he adds the equivalent of 50,000 miles of wire to the capacity of the lines of the Western Union Telegraph Company, and cheapens by one-half, at least, the transmission of telegrams the world over. The managers of this great corporation can well afford to say to him: "Retire to your workshop at Menlo Park, and consecrate your life to Invention as a mission.

"Other men may be permitted to sell the product of their brain after it has been tested and found useful. Humanity draws on you for all you can invent, and stipulates in advance that there shall be

no cramp on your energies, nor hindrance on your powers through lack of means."

He had reached this degree of success at twenty-three years of age, though he had never attended a college, nor heard a course of scientific lectures, nor enjoyed any of the supposed advantages which wait upon endowed efforts in behalf of education.

At the age of twenty-four he had forty-five distinct inventions under way at once, and the United States Patent Commissioner described him as "the young man that kept the path to the Patent Office hot with his footsteps."

And yet the quadruplex telegraph figures among Edison's inventions only as a particularly bright constellation in the midst of the starry heavens. It is covered by barely eleven patents, while his stock telegraph instrument requires forty patents to fully protect its points of originality, and his automatic system of telegraphy requires forty-six. Including the improved dynamo-machines, regulators, coolers, switches, conductors, and lamps, upon which patents have been or will be secured, before the electric light can be made fully available to the public, a hundred patents may be required.

On one occasion, at four o'clock in the afternoon, he made a discovery; he instantly "wired" the fact to his solicitor at Plainfield. At nine o'clock that night his solicitor had cabled an application for the patent to London, and at seven the next morning he

was awakened by word from London that his application for a patent had been there received. He presides over a factory in which the only output is ideas, the sole product is patents, and the immediate profits are discoveries. It is the most perfect, and perhaps the only enterprise of the kind, conceived solely with a view to practical utility, the world has ever known. It is believed, also, that in few business enterprises have the ultimate financial profits borne a larger ratio to the investment and the risk.

Whence comes this brilliant Electric Light, whose burning genius draws the attention of the thinking world to Menlo Park?

Thomas A. Edison was born on the 11th of February, 1847, at Milan, Erie Co., Ohio, and there lived to the age of seven. Milan is at the head of navigation on the Huron River, ten miles from Lake Erie, and was then a thriving young town of three thousand inhabitants. As a lake port it continued to have a trade in grain and lumber, and some shipbuilding, until the Lake Shore Railway, running a few miles to the southward of it, nearly extinguished the town. Forth from this obscure Nazareth shone one who, if not destined to be the very sun of the earth's scientific illumination, is at least one of its most powerful electric lights.

Two essays might here be written—the one on the obscurity of the birthplaces of the great, the other on the dependence of American cities on means of

transportation. The atmosphere of large cities is favourable to the development of superficiality and pert smartness in small boys, but is peculiarly fatal to thorough investigation or sustained genius. Now and then a boy born among crowded streets and tiled roofs—like Schuyler Colfax, who was born under the shadow of St. John's Church, in New York City, or like Charles Dickens, or Benjamin Franklin—overcomes the dissipating influences of city birth, and earns true eminence. But in proportion to the large populations gathered in cities, the number who rise to distinction in immediate connection with city influences is extremely small.

Edison found in Milan's little river, lumpy hills, and clumpy forests, the opportunity for much good healthy sport, and some ingenious experiment. He was not demure or prematurely serious, but rosy-faced and laughing. Still, he liked to build things, if it was only a canal through the sand, scooped out with a shingle.

Of his inventive genius at this period his sister tells the best story. When the boy was a little under six years old he became greatly interested in the fidelity with which an old goose was brooding her nest of eggs. When the young family of golden-green goslings came out and took to the water, he was told that this astounding result was produced simply by the animal heat of the old bird sitting on them.

This first lesson in organic chemistry was of a

kind too remarkable to be let slip without testing it by experiment. Soon after, the boy was missed. Messengers were sent after him everywhere, but he could not be found. "By-and-by," says the sister, "don't you think father found him curled up in a nest he had made in the barn, sitting on goose eggs and hens' eggs, and trying to hatch them?" But who knows? Perhaps the talent for invention was not all confined to the brother. People who have lived long in the West, and know the ways of the country, will hold that the sister has a trace of it too.

It must be said, however, that up to the age of seven years the best evidence that Thomas A. Edison would turn out well was under ground. It was to be found in his ancestry.

His great-grandfather, Thomas Edison, had been a prominent bank officer and financier in New York during the American War. As such his name appears as the only signature for authenticating the genuineness of the Continental currency.

The family of Edisons had migrated to America in 1730, and from thence can still be traced backward for a century, as a family of extensive and prosperous millers in Holland.

The Edison of the Revolution died at the age of 102 years. His son, the inventor's grandfather, lived to be 103 years old. Following him comes Samuel Edison, still living (1887), at the age of eighty-three, and brisk and active for all the details of business.

When sixty-four years old he outjumped 260 men belonging to a regiment of soldiers stationed at Fort Gratiot, Mich. As a boy he had learned the tailoring trade, an unusual choice for one who, as a young man, became six feet and two inches in height, and was of commanding face and figure. As he approached manhood he entered commercial life, becoming an extensive trader in timber, and subsequently in produce. He was born August 16th, 1804, in the town of Digby, County of Annapolis, Nova Scotia, but before reaching seven years of age had resided successively at Newark, New Jersey, and at Bayham, Upper Canada. In Canada he married Miss Nancy Elliott, the mother of Thomas Alva, at Vienna. She was of Scotch and English parentage, well educated, and had been for several years a popular teacher in a Canadian high school. In 1837 he came as far west as Detroit, Mich., with his accomplished wife, then twenty-seven years of age. She is described as attractive, highly cultured, and social. Remaining at Detroit one year, he then removed to Milan, Ohio, where Thomas Alva was born.

Mrs. Edison felt a tender affection for Thomas Alva. He combined, with the pure strong current of vitality which came to him from his father, the keen social vivacity and capacity for intense intellectual effort which distinguished his mother. This she had many opportunities of knowing, though, at a time when many college students are drawing their prizes,

her devoted son was wandering out of one town into another, suffering repeated discharges, mishaps, and disappointments. On April 9th, 1871, just as Thomas Alva's success was beginning, and before his name had yet become great, though its lustre was already bright enough to gladden her loving heart with prophetic pride, she passed away from this life. Besides Thomas A., she left a son, William P. Edison—a prominent business man in Port Huron, Mich., where Samuel Edison, the father, also resides—and a daughter, Mrs. Homer Page, a resident of Milan, Ohio.

The new home to which Thomas A. Edison was removed, at seven years of age, at Port Huron, Mich., was a large white farmhouse located in an extensive grove, overlooking the broad river or strait which there separates the dominions of the Queen from the Great Republic. It was a superior home, architecturally, intellectually, and socially. Here, at the hands of his mother, Thomas got all the instruction he ever received from a teacher, except a short attendance of two months at school. The best proof that she got away from the mere words in which truth must be appareled, and let him into the heart of things, appears in the fact that, long before he became learned, he was deeply in love with learning.

Before he was ten years of age he had read, not carelessly but in course and absorbingly, such works as the "Penny Cyclopædia," Hume's "History of England," D'Aubigné's "History of the Reformation,"

Gibbon's "Decline and Fall of the Roman Empire," and Sears' "History of the World." While these were his literature, chemical and scientific works, as fast as he could devour them, were his aliment and life. This is evident from the fact that when, two years afterwards, he obtained access to the public library at Detroit, he actually set about reading the whole library, shelf by shelf. Commencing at the bottom shelf, he struck into such dusty and difficult books as Newton's "Principia"—a book over which Voltaire spent two years in preliminary study of mathematics in the effort to master, but could not, and with which Goethe had a hardly more successful tilt. Madame de Staël boasted of having comprehended it, but probably a hundred persons in any one age are as many as have thoroughly understood it.

Besides these he found on the same shelf Ure's scientific dictionaries and Burton's "Anatomy of Melancholy." He read the first fifteen feet, omitting no volume, and no line or word in any volume. By this time he found it more profitable to select the special works in which he could satisfy the developing bent and trend of his mind. As a pure example of the love of learning which it is possible for an educated mother to impart and instil in the mind of a "brainy" boy, this single illustration is probably unsurpassed. It is equal to Everett's learning Greek at four years of age, or to Pope's "lisping in numbers." How such an influence contrasts with that of the

relatives of Richard Cobden, who sent him for five years to a boarding-school in Yorkshire, very much of the quality of Dotheboys Hall, and where from his tenth to his fifteenth year he was "ill-fed, ill-taught, ill-used," never seeing mother, father, nor friend, during his entire misnamed process of "education."

Among the books read by Edison at this period, none chained him with such delight as Hugo's "Les Misérables" and "Toilers of the Sea." The former he read a dozen times, and the latter he regarded as a work in which, great as is the art displayed in it, it is buried under the magnificent beauty of a stupendous wealth of physical, intellectual, and moral nature.

It is a proof that young Edison had no merely abnormal or one-sided development of genius, that he plunged thus at once into profound sympathy with the world's great reservoirs of learning, and also with its most gifted instructors of the imagination. Even at this early age, these authors made such an impression on his mind that he could refer usually to the very book and page where any fact, incident, or words used in them occurred. This habit still clings to him, now that he has occasion often to ransack the most recondite scientific authors for facts or suggestions. He thus reinforces the saying that "Genius is an exhaustless capacity for work in detail." But what was this boy doing as a boy, out of doors and among boys, when he was delving into Newton's Physics, Ure's Chemistry, and following Victor Hugo's Jean Valjean?

CHAPTER II.

THE TRAIN-BOY.

EDISON was a train-boy on the Grand Trunk Railway, between Port Huron and Detroit, selling apples and figs, magazines and newspapers. Imagine a boy, with the recollection of last night's efforts to comprehend the "Principia" still imparting a studious cast to his face, bouncing into the car, with his basket on his arm, and crying, "Figs and candies, Sir!—Madam! Every packet warranted to contain a prize, or your money returned," and so on. But Thomas A. Edison not only "caught on" to all the good points of the business, but he improved on them, and increased his trade so rapidly that he was soon employing four assistants. By this means he was able to turn over to his parents an annual profit of about five hundred dollars during each of the four years, beginning with his twelfth and ending with his sixteenth, in which he pursued this occupation. Compared with the boy who goes to college and costs 500 dollars (about £100) a year, he was a net profit to his parents of more than 3½ dollars per day, during what is usually the least productive and most expensive years of a child's life.

It is not the fact that children work that retards their physical, moral, or intellectual growth, but the

fact that they work at forms of work to which they are not adapted, and work without the key or clue to the great art of making work free and noble. It is not true or possible that all work should be so pleasant that it can be pursued passionately or lovingly. This was Fourier's dream, but it would abolish the distinction between work and dissipation or play, and between labour and rest. This distinction is essential to make each a relief to the other, and thus to enable one person daily to derive pleasure from both.

Had young Edison been condemned to read fifteen solid feet of books of reference on the lower shelf of the Detroit Library as a task, he would have welcomed the privilege of selling apples on the train as play.

One of the first original expedients he adopted to increase his trade in papers was to telegraph in advance the headlines of his war news, and have them bulletined at the various stations. These bulletins would detain all transient customers until the train came, when his whole stock would be grabbed up instantly, because of the stimulus he had given to the public appetite.

His next enterprise was to print and publish a paper of his own, the first, and perhaps still the only newspaper ever edited, set up, struck off, and published wholly on a railway train in full motion. It was a weekly, twelve inches by sixteen, printed on one side only, for the impressions were all made by a

pressure of the hand. He had bought 300 lbs. of type from the *Detroit Free Press*, and so was his own printer, but he did not care to go to the expense of a press. He kept within what would pay.

He got the use of the smoking-room in a springless half-freight car, or what is generally known in the Western States of America as a "caboose," but which, not being very well ventilated or inviting, was but little used by passengers. In this room Edison wrote and set up his items of railway gossip, the local news of the train and the stations. He sold, at three cents a copy, several hundred copies each week of this paper, called *The Grand Trunk Herald*, and received, occasionally, contributions from eminent railroad men, who were interested in the paper because they had once been boys themselves, and knew, therefore, what it was to be a boy. Robert Stephenson, then building the tubular bridge at Montreal, ordered an extra edition for his own use. The London *Times* gave it a first-class notice; and indeed, it was this paper that first gave Thomas A. Edison an international reputation.

The third innovation on the part of our train-boy was even more sensational, though less successful. Purchasing a supply of chemicals, a work on the "Qualitative Analysis," and some retort stands from the men in the railroad shops, he opened a chemical laboratory in the same old railroad "caboose" in which he was printing *The Grand Trunk Herald*. One would suppose his four salesmen must have

borne the brunt of the peddling on the train at this time. Perhaps, however, the first application of the quadruplex principle may have consisted in Edison's work in selling newspapers, editing and printing his own journal, reading fifteen feet of a public library, in which Newton's "Principia" figured as one and a quarter inches, and running a chemical laboratory all at once.

The chemical laboratory in the smoking "caboose" was the logical sire to the electrical laboratory at Menlo Park.

What great inventions might have issued from this duplex railway caboose it is impossible to say; but one day a bottle of phosphorus, from which the water had evaporated, fell to the floor through an extra jolt of the car, and exploded. Instantly the car was on fire, and an unscientific conductor, fearing, perhaps, that he would be charged with burning up his own train, not only pitched the types and chemicals out of the window, but as soon as the burning train could be stopped, soundly boxed the ears of the young student of Newton's "Principia" and Fresenius' "Qualitative Analysis," and threw him off also. Thus the investigation of the mysteries of chemical law was suddenly brought to an end by the hard blows of brute force, very much as the sorcerers of a few centuries earlier were taught better than to try to analyse flame, by being delivered to the flames themselves for analysis.

Gathering up his scattered materials, the boy removed his chemical laboratory to the basement of his father's house, where he continued, under more genial auspices, his chemical experiments. From thence also he issued a new and better printed journal, which he entitled *Paul Pry*.

This journal had both contributors and subscribers; but by one of the usual accidents of journalism it offended one of its subscribers, who, meeting the boy on the margin of the St. Clair, deliberately pitched him into the river. So much more effective is the law of libel at all times against small boys than it is against men!

Edison's punishment of the ruffian was characteristic. He from thenceforth excluded his name peremptorily from the columns of *Paul Pry*. That route to fame was closed to him. Then he would have defined Edison as the train-boy whom he threw into the water; to-day he would himself be defined as the man that threw Edison into the water.

As a train-boy, Edison's earliest studies were not in the laboratory. He frequently rode with the engineer in order to study more carefully the mechanical principles of the locomotive. In the basement of his father's house he had constructed on a small scale a working engine. Whenever he could visit the railroad machine shops he did so, and when he did "he took it all in." If in any of these trips the engineer fell asleep, Thomas was not the boy to

wake him up; for his compassion was such that he knew the man needed rest. He would run the engine himself. On the first of these occasions he pumped too much water into the boiler, and this being thrown from the smoke-stack, doused the engine with filth. This was merely an incident however, and to his mind was far more satisfactory than not to have run the engine at all.

Edison's experience as a train-boy, in advertising his papers in advance of their arrival, naturally interested him in the electric telegraph. On removing his laboratory from the "caboose" to his new basement rooms at home, he purchased a standard work on the telegraph, and proceeded to build a line connecting this basement with the residence of James Ward, his assistant.

Mr. Reid, in his memorial volume, seriously declares that Edison and Ward undertook to generate the current by rubbing together the backs of two cats. But then Reid is himself from the State of Ohio, and was once a reporter. No person can stand in these two relations to the world and make no use whatever of the inventive faculty.

The boys did, however, secure a current, through stove-pipe wire, insulated by bottles where it was strung to trees, and making use of a fragment of genuine cable, obtained in the usual way in which boys find things which they want, as a means of maintaining the insulation where their short line

passed under the road. Their magnets were at first made of old wire wound with rags, but the two boys, being in receipt of an independent income from their commercial business, found it easier to buy some second-hand batteries and telegraphic instruments, with which their line was instantly established as a good working short line.

Just then, young Edison had the good-fortune to rescue the child of the station-agent at Mount Clemens, near Port Huron, from being run over by the train. It was a brave, heroic action, and excited the warm gratitude of the father of the little boy. Learning the deep interest which Edison took in everything relating to telegraphy, the agent, Mr. J. A. Mackenzie, volunteered to teach him the practical art of operating. Thomas Alva was still a train-boy, and his duties as such filled the day. It was now arranged, however, that returning each night by a freight train to Mount Clemens, Mackenzie would teach him the new employment. In five months after taking his first lessons, Edison was able to accept an offer of 25 dollars (about £5) per month to operate the Port Huron office, with extra pay for extra work. He had emerged from the train-boy into the telegraph operator and was beginning to be sixteen years of age.

CHAPTER III.

THE TELEGRAPH OPERATOR.

As an operator, young Edison was constantly learning too much to be useful. He would have succeeded better if he had been duller. Some of his escapades arose from his unconquerable impulse to experiment, when the thing wanted from him was routine work. On other occasions he got into serious disgrace for that absent-mindedness which is the nearly constant accompaniment of inventive force or deep thought. He was even accounted "luny" for ventilating his theories of duplex and quadruplex transmission.

The notion that telegraphy was in a crude state was in itself a sign of unbalanced judgment with many. But when to this was added the egotistical conceit that he himself would succeed in evolving some of the possible improvements in the art, he was set down as crazy.

His work at Port Huron ended after six months, because he could not get the pay for extra work which his employer had agreed to give him. Before leaving Port Huron, however, he had secured an engagement as night operator at Stratford, Canada. Here he made his first invention. Being required to report "six" every half-hour to his circuit manager, to show

that he was awake, Edison, feeling that he could make better use of his time than to conform to this senseless requirement, rigged a wheel with Morse characters upon it, so that the watchman, by simply turning the crank, could perform this duty while Edison worked or slept.

Here he was discharged in a rage, and for very good cause. Receiving over the wire an order to hold a train, he repeated back the message instead of showing it immediately to the conductor. By this delay the train left without warning, and only by the two trains meeting on a long, straight track and checking up in time was a collision avoided. The railroad superintendent threatened to punish him criminally, and Edison was glad to leave for home without stopping to take with him that which on the Canadian side would have been "luggage," but as he crossed the Detroit River became "baggage," "traps," "gripsack," or "plunder," according to the State and county he was in.

During his short vacation at Port Huron, Edison taught a new trick in telegraphing to the railroad employees at that point and at Sarnia, on the opposite shore of the river. An ice-jam had broken the cable between the two points, and it could not be immediately repaired; communication between the two towns was stopped. Edison thought an operator on the opposite shore would recognise the sounds of the telegraphic alphabet if made from a locomotive.

Mounting his "instrument," he tooted off the signal "Hallo, Sarnia! Do you get me?"

At first there was no answer. But presently an operator at Sarnia recognised the distant signals. Instantly mounting a locomotive on that side he replied, and communication was re-established.

After a few weeks' vacation at Port Huron, he obtained employment at Adrian, Mich., but was almost immediately discharged for violation of rules in holding the wire from all comers, because he had a message from the superintendent. The latter, hearing the tussle for possession of the wire, rushed in and discharged him. From thence he went to Fort Wayne, where he was so well liked that after two months he was promoted to a position at Indianapolis.

Here he invented an automatic repeater, which transferred the telegram from one line to another without the medium of a sending or receiving operator. At his next engagement, in Memphis, he had an opportunity to put this automatic repeater in operation, so that Louisville and New Orleans despatches could pass through the Memphis office direct, thus saving the work of one operator. For this he was complimented while at Memphis, yet on the whole his ambition to experiment was regarded as a clog on his working value for routine purposes. Simultaneously with the compliments he received he was discharged, because the management thought his head was too full of duplex transmission.

Thus at the early age of seventeen he was alternately complimented and starved for his genius, by men who were fat and successful because they were too busy to think.

At Indianapolis he endeavoured to eke out his skill in taking the "press report," which is one of the highest achievements in telegraph operating, by adjusting two additional recording registers, one to receive, and the other to repeat the embossed writing at slower speed, so that it could be copied. This, he thought, would enable him to receive as fast as the sending operator could send. The press reports lagged, however, in transmission, notwithstanding his increased aids for receiving, and on this complaint he was suspended from Indianapolis, and transferred to Cincinnati, on a day-wire.

Determined, however, to master the most difficult and remunerative part of his work, he still "subbed" for the night men as often as he could. This industry soon led to his promotion. Coming down to "sub" in this way on one occasion, he found the night men had struck, and were off on a general carouse. Edison, finding the office deserted, took the press report as best he could, working alone until morning. On the next day his salary was raised from 65 to 105 dollars per month, and he was given the Louisville wire, one of the most desirable in the office.

The "sender" at the Louisville end was Bob

Martin, one of the most expert senders in the country; Edison's practice with him rapidly perfected his own hand.

During all this time Edison was only secondarily intent on his progress as an operator. For dress, leisure, or dissipation he had absolutely no time or thought. He was willing to work at all hours, night or day, and would give his money freely in helping shiftless fellow-workmen. But his mind was aglow with the labours and experiments whereby he was seeking to perfect a remarkable steam-engine, and to solve his great problem of duplex transmission.

What with the money he had expended on books and apparatus, and in aiding his dissolute companions, he found himself, when discharged at Memphis in 1864, without a penny. He walked to Nashville, and thence, in company with William Foley, who was in like distress, to Louisville. He had but one suit of clothes; they were of linen, and the weather was cold. He succeeded in borrowing a little money for clothing, and on the recommendation of Foley, who was too dissipated to get work for himself, he found employment. For this service Edison supported Foley until he too got work.

Edison worked hard at the practical part of his business, and remained a close drudge for two long years. Penury, rats, squalor, and the dissipation of his companions, for the time damped the energy of his inventive genius. He seems to have felt the

stern probability that all his hard studies would prove to be mere dreams of the mirage, and that all his life would be sunk in the struggle for a living.

Even under these discouragements his inventive force came to his aid. The line he was working was so old and dilapidated that constant interruptions and changes occurred, with corresponding differences of strength in the circuit. To avoid this he arranged three sets of instruments, each with a different adjustment, so that whether the circuit was strong or weak he could receive the signals accurately.

About this period a strong feeling existed in the Southern and Border States in favour of an exodus from the disrupted and collapsed Confederacy into South America. Though this feeling originated among the defeated Confederates, it caught many others in its whirl. It was an emigration craze, with political disgust as its inspiring impulse. Although Edison did not sympathise with the impulse, he was caught in the craze. He determined, with two of his associates, Keen and Warren, to go to South America by the way of New Orleans. Reaching the latter place, Edison found the vessel gone by which he had intended to sail; he also fell in with a Spaniard who had been all over the v
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and especially of South
to go home to his pa

returned, and after a pleasant visit at Port Huron he returned to Louisville and resumed his work.

At this time he wrote a work on electricity which he expected to print, but his lack of means prevented. He spent much time in perfecting his handwriting, and developed a highly artistic backhand which he became able to produce at a speed of forty-five words per minute—the most that a Morse operator could send.

At this juncture Edison's ill-luck returned. Underneath the battery-room of the new telegraph office, into which his work had recently been moved, were richly furnished banking-rooms. One night when Edison was engaged in abstracting from the battery-room some sulphuric acid for the private experiments in which he was engaged he upset the carboy. The acid ran through the floor upon the furniture and carpets below, doing great damage. The formidable and irrepressible Edison was promptly discharged. He went to Cincinnati and worked a while, spending his evenings in the mechanics' library there, studying everything bearing upon chemistry and electrical science. The simple wonder was that such a soul so devoted to all-absorbing problems could hold any situation, or perform any routine work whatever.

From Cincinnati he returned home to Port Huron —the haven to which his battered prow always turned from the pitiless storm of adverse fate, a fate made

passed under the road. Their magnets were at first made of old wire wound with rags, but the two boys, being in receipt of an independent income from their commercial business, found it easier to buy some second-hand batteries and telegraphic instruments, with which their line was instantly established as a good working short line.

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As an operator, young Edison was constantly learning too much to be useful. He would have succeeded better if he had been duller. Some of his escapades arose from his unconquerable impulse to experiment, when the thing wanted from him was routine work. On other occasions he got into serious disgrace for that absent-mindedness which is the nearly constant accompaniment of inventive force or deep thought. He was even accounted "luny" for ventilating his theories of duplex and quadruplex transmission.

The notion that telegraphy was in a crude state was in itself a sign of unbalanced judgment with many. But when to this was added the egotistical conceit that he himself would succeed in evolving some of the possible improvements in the art, he was set down as crazy.

His work at Port Huron ended after six months, because he could not get the pay for extra work which his employer had agreed to give him. Before leaving Port Huron, however, he had secured an engagement as night operator at Stratford, Canada. Here he made his first invention. Being required to report "six" every half-hour to his circuit manager, to show

that he was awake, Edison, feeling that he could make better use of his time than to conform to this senseless requirement, rigged a wheel with Morse characters upon it, so that the watchman, by simply turning the crank, could perform this duty while Edison worked or slept.

Here he was discharged in a rage, and for very good cause. Receiving over the wire an order to hold a train, he repeated back the message instead of showing it immediately to the conductor. By this delay the train left without warning, and only by the two trains meeting on a long, straight track and checking up in time was a collision avoided. The railroad superintendent threatened to punish him criminally, and Edison was glad to leave for home without stopping to take with him that which on the Canadian side would have been "luggage," but as he crossed the Detroit River became "baggage," "traps," "gripsack," or "plunder," according to the State and county he was in.

During his short vacation at Port Huron, Edison taught a new trick in telegraphing to the railroad employees at that point and at Sarnia, on the opposite shore of the river. An ice-jam had broken the cable between the two points, and it could not be immediately repaired; communication between the two towns was stopped. Edison thought an operator on the opposite shore would recognise the sounds of the telegraphic alphabet if made from a locomotive.

Mounting his "instrument," he tooted off the signal "Hallo, Sarnia! Do you get me?"

At first there was no answer. But presently an operator at Sarnia recognised the distant signals. Instantly mounting a locomotive on that side he replied, and communication was re-established.

After a few weeks' vacation at Port Huron, he obtained employment at Adrian, Mich., but was almost immediately discharged for violation of rules in holding the wire from all comers, because he had a message from the superintendent. The latter, hearing the tussle for possession of the wire, rushed in and discharged him. From thence he went to Fort Wayne, where he was so well liked that after two months he was promoted to a position at Indianapolis.

Here he invented an automatic repeater, which transferred the telegram from one line to another without the medium of a sending or receiving operator. At his next engagement, in Memphis, he had an opportunity to put this automatic repeater in operation, so that Louisville and New Orleans despatches could pass through the Memphis office direct, thus saving the work of one operator. For this he was complimented while at Memphis, yet on the whole his ambition to experiment was regarded as a clog on his working value for routine purposes. Simultaneously with the compliments he received he was discharged, because the management thought his head was too full of duplex transmission.

Thus at the early age of seventeen he was alternately complimented and starved for his genius, by men who were fat and successful because they were too busy to think.

At Indianapolis he endeavoured to eke out his skill in taking the "press report," which is one of the highest achievements in telegraph operating, by adjusting two additional recording registers, one to receive, and the other to repeat the embossed writing at slower speed, so that it could be copied. This, he thought, would enable him to receive as fast as the sending operator could send. The press reports lagged, however, in transmission, notwithstanding his increased aids for receiving, and on this complaint he was suspended from Indianapolis, and transferred to Cincinnati, on a day-wire.

Determined, however, to master the most difficult and remunerative part of his work, he still "subbed" for the night men as often as he could. This industry soon led to his promotion. Coming down to "sub" in this way on one occasion, he found the night men had struck, and were off on a general carouse. Edison, finding the office deserted, took the press report as best he could, working alone until morning. On the next day his salary was raised from 65 to 105 dollars per month, and he was given the Louisville wire, one of the most desirable in the office.

The "sender" at the Louisville end was Bob

Martin, one of the most expert senders in the country; Edison's practice with him rapidly perfected his own hand.

During all this time Edison was only secondarily intent on his progress as an operator. For dress, leisure, or dissipation he had absolutely no time or thought. He was willing to work at all hours, night or day, and would give his money freely in helping shiftless fellow-workmen. But his mind was aglow with the labours and experiments whereby he was seeking to perfect a remarkable steam-engine, and to solve his great problem of duplex transmission.

What with the money he had expended on books and apparatus, and in aiding his dissolute companions, he found himself, when discharged at Memphis in 1864, without a penny. He walked to Nashville, and thence, in company with William Foley, who was in like distress, to Louisville. He had but one suit of clothes; they were of linen, and the weather was cold. He succeeded in borrowing a little money for clothing, and on the recommendation of Foley, who was too dissipated to get work for himself, he found employment. For this service Edison supported Foley until he too got work.

Edison worked hard at the practical part of his business, and remained a close drudge for two long years. Penury, rats, squalor, and the dissipation of his companions, for the time damped the energy of his inventive genius. He seems to have felt the

stern probability that all his hard studies would prove to be mere dreams of the mirage, and that all his life would be sunk in the struggle for a living.

Even under these discouragements his inventive force came to his aid. The line he was working was so old and dilapidated that constant interruptions and changes occurred, with corresponding differences of strength in the circuit. To avoid this he arranged three sets of instruments, each with a different adjustment, so that whether the circuit was strong or weak he could receive the signals accurately.

About this period a strong feeling existed in the Southern and Border States in favour of an exodus from the disrupted and collapsed Confederacy into South America. Though this feeling originated among the defeated Confederates, it caught many others in its whirl. It was an emigration craze, with political disgust as its inspiring impulse. Although Edison did not sympathise with the impulse, he was caught in the craze. He determined, with two of his associates, Keen and Warren, to go to South America by the way of New Orleans. Reaching the latter place, Edison found the vessel gone by which he had intended to sail; he also fell in with a Spaniard who had been all over the world, and who gave him so vivid a picture of the inferiority of most other parts, and especially of South America, that he determined to go home to his parents in Michigan. So he

returned, and after a pleasant visit at Port Huron, he returned to Louisville and resumed his work.

At this time he wrote a work on electricity, which he expected to print, but his lack of means prevented. He spent much time in perfecting his handwriting, and developed a highly artistic backhand, which he became able to produce at a speed of forty-five words per minute—the most that a Morse operator could send.

At this juncture Edison's ill-luck returned. Underneath the battery-room of the new telegraph office, into which his work had recently been removed, were richly furnished banking-rooms. One night, when Edison was engaged in abstracting from the battery-room some sulphuric acid for the private experiments in which he was engaged, he tipped over the carboy. The acid ran through the floor upon the furniture and carpets below, doing great damage. The formidable and irrepressible infant was summarily discharged. He went to Cincinnati and worked a while, spending his evenings in the mechanics' library, closely studying everything bearing upon chemical and electrical science. The simple wonder was that with a soul so devoted to all-absorbing problems he could hold any situation, or perform any routine work whatever.

From Cincinnati he returned home to Port Huron—the haven to which his battered prow always turned from the pitiless storm of adverse fate, a fate made

adverse by the fact that the business of the world, by a magnetic law, attracts diligent and safe mediocrity, but repels genius. Very few successful business men can recognise genius when they see it; what they look for is tact, cunning, presuming "cheek," audacity, complacency, self-sufficiency, subserviency, pliancy, and the art that

> "Crooks the pregnant hinges of the knee,
> That thrift may follow fawning."

Genius is none of these. It is nervous, restless, non-expert in the little trading shrewdnesses and cunnings that distinguish men who are great in trade. And yet genius must find and must ask of these the privilege of being known. Edison was still a tramp because he had not found them. But he was a lively tramp. A friend, Mr. F. Adams, in the telegraph office in Boston, recommended him to the manager, G. F. Milliken, as the proper man to work a difficult New York wire. Edison came, and found in Milliken, who was himself an inventor, and an accomplished telegrapher and gentleman, the second person who detected in his nervous, fiery eye the light of genius. The first had been his mother.

He reached Boston in his twenty-first year. Of course he opened in Boston that inevitable "shop," in which he gave all his spare time to experiment, as he had done when a train-boy on the Grand Trunk, when an operator at Indianapolis, Louisville,

Cincinnati, and Memphis. Inventions now were beginning to chase each other through his fertile brain like white clouds flecking the blue sky in harvest time.

He invented a dial instrument, for use by those who would wish to establish private lines to their own houses or offices without spending tediously the time required to learn the art of telegraphing; also a chemical vote-recording apparatus, which the Legislature of Massachusetts was asked to adopt, but would not. He also here made his first private-line printer.

CHAPTER IV.

AS AN INVENTOR.

AFTER two years of work in Boston in the employment of the Western Union Telegraph Company, Mr. Edison came to New York. His shop, books, experiments, and companions had together left him penniless. For three weeks he hunted for work in the various telegraph offices without success. Even the fact that he had, previous to his arrival in New York, made a trial experiment of his duplex system, assisted by Mr. F. L. Pope, patent adviser of the Western Union Telegraph Company, did not seem to amount to an effective introduction to the hard-headed capitalists running that great concern.

Though not fully satisfactory, his duplex system presented the clear promise and potency of a great success. Yet the ingenious inventor was wholly unsuccessful in getting work, was substantially without suitable clothing, and was frequently suffering even for food.

Still looking for a job, he stepped into the office of the "Laws Gold Reporting Telegraph Company," then engaged in reporting the quotations of gold. He found the instrument which Mr. Laws had invented for reporting the gold market would not work, and its inventor was utterly unable to set it right. Edison thought he could set it right, and was allowed to try. The case seems to have been like that of the disabled limb at Madison, Wis., which eight medical experts pronounced a fracture, and treated as such for eighteen months. At length a "natural bonesetter" was called in, and he in a moment clicked the bone back into its socket, and proved that it was a dislocation of the shoulder, and no fracture at all. In an instant Mr. Edison had the machine working again, and this secured him work not merely for that week or month, but for life. The Indicator Company set him at work permanently. Soon after he invented his "Gold and Stock Quotation Printer," and formed a co-partnership with Pope, in connection with whom he brought out the Pope and Edison Printer. In a short time the Gold and Stock Telegraph business was conducted almost entirely by means of his

inventions. Here a permanent arrangement was made by which he was brought into the joint employment of the Gold and Stock Telegraph Company and the Western Union Telegraph Company at a handsome salary.

Under this engagement a large electrical manufacturing establishment, employing 300 men, was provided for him, and erected under his superintendence. Any required capital was placed at his disposal, and while at first electrical apparatus was to be the output of the factory, inventions and experiments multiplied at a rate that rapidly transformed it into a manufactory of inventions and patents chiefly.

His method of work was literally Napoleonic, especially in his capacity for long endurance of unremitting labour without sleep, and then for uninterrupted sleep sufficient to restore the even balance of the system.

Immediately after making certain improvements in his Gold and Stock Quotation Printer, an order was received for 30,000 dollars' worth of the new printers. The model had worked well in his experiments, but the first instruments turned out failed. At first the difficulty seemed to defy all remedy, until, taking a few of his most expert men to the top floor of his factory, he told them they must all stay there until the printer was a success. After sixty hours of uninterrupted labour, without a moment of sleep, he had discovered and overcome the difficulty. Then

he went to bed and slept thirty-six hours at a stretch.

In these periods of strain and tension on the brain, when the first ordinary period for sleep has passed without sleep, the capillary vessels of the brain lose, for the time, their elasticity, and become temporarily congested, causing an abnormal activity of thought and capacity for invention. The ideas flow in upon him with unwonted energy, and so far from feeling a desire for sleep, he could not sleep until the discovery is made without a special effort. This intensity keeps on increasing ; and thus far, fortunately, he has always accomplished his end before the danger point is reached, at which the blood would refuse to retire from the brain, and sleep would be impossible without medical aid. In this way he is able to defy the distinction between day and night with impunity, and to work without stint, certain that when his end is reached he can sleep without difficulty.

In this respect very active minds have presented a marked difference. Henry Ward Beecher could sleep up to the very instant when he would be required in the pulpit or on the platform, and, if need be, drop into slumber again the instant his work as a preacher was finished. In this way he never lacked for sound, healthy sleep, and to this he attributed his great capacity for work. Charles Dickens, on the contrary, died of the passively congested condition of his brain, brought on by his lecturing tour in the United States,

a congestion which he in vain endeavoured to walk off by taking long strolls after his return to England. Mr. Gladstone resorts to chopping wood, after exciting sieges in Parliament, to restore his sleep. Dr. Lyman Beecher used, during the excitements of powerful revivals, to resort to playing on his violin and dancing breakdowns in his stocking-feet, to work off the semi-congested condition of his brain caused by suspending his hearers over the terrors of the flaming pit after the traditional method of the first half of the century. Horace Greeley died of the congestion of the brain caused by his campaign for the Presidency, and the nervous exhaustion induced by his defeat. Whitelaw Reed, while at Zenia, Ohio, during his earlier life, was compelled to betake himself to two years of wood-chopping in Minnesota before he could recover his facility of sleep.

Let none suppose, therefore, that the experiments which Napoleon and Edison have proved themselves able to survive with safety, can be imitated with impunity by all. It may probably be laid down as a nearly universal fact that none can sustain these long periods of wakeful toil and then sleep off the consequences, except those who have acquired the habit gradually, who are descended from particularly healthy ancestors whose longevity and mental balance have been marked, who have formed no vicious, sensual, or exhausting habits, and indulge in no other excesses, who have no cause of domestic or emotional

unhappiness to supplement the evil tendencies of this loss of sleep, and who habitually abstain from both stimulants and narcotics, and especially from alcoholic liquors, wines, tea, coffee, tobacco, quinine, morphine, and chloral.

The inventions of Mr. Edison, which have had the greatest financial value, have been the Gold and Stock Quotation Printer, the Duplex and Quadruplex Telegraph, the Carbon Speaking Telephone, and the Electric Incandescent Light. His quadruplex system, the President of the Western Union Telegraph Company officially reports, has "saved the Company five hundred thousand dollars yearly in construction." By this system, four distinct messages, two in each direction, pass simultaneously over a single wire. Experiments are now pending to develop the quadruplex system into a sextuplex, and even octoplex, or in which six or eight distinct messages will pass in opposite directions over the same wire simultaneously. The progress already made is equivalent to the addition, or rather to obtaining all the efficiency without any of the cost of construction, which would be given by 70,000 miles of additional wires to those of the Western Union Telegraph Company. It was in 1874, while running the large factory at Newark, and experimenting with the view of making certain modifications in a duplex apparatus by Stearns, that Edison conceived of the principle of quadruplex transmission. This consists

in sending messages simultaneously over the same wire, one message by the double current system, and one by the single current or open circuit system. The technique essential to an explanation of the two systems of transmission, as well as of the means used to prevent their interference with each other, cannot be acquired without the aid of a competent treatise on electrical science, as the very terms used in the description, together with the assumptions as to the workings of the electric force, amount to a vast and intricate science, that might well form the study of a lifetime. For a careful explanation of the duplex and quadruplex systems the reader is referred to Wormell's edition, from the German, of Dr. Alfred Ritter Von Urbanitzky's treatise on electricity, with an introduction by Perry, published, under the title of "Electricity in the Service of Man," by Messrs. Cassell & Company, London (1886), where an illustrated presentation of both the differential method and the bridge method appear. In the race of invention European and American inventors divide with each other the honour of nearly every discovery. Meyer is the European inventor whose credit in connection with the evolution of multiplex telegraphy competes with that of Thomas A. Edison in America. In the work referred to, Meyer's system is described. The same work, however, describes more than twenty of Mr. Edison's inventions. Among these are his apparatus for the separation of metals,

or magnetic ore separator, which is a machine for the separation of iron ore by means of magnets, and is distinguished by its marvellous simplicity. Chenot and Froment, in 1852, had made use of powerful magnets in separating magnetic from non-magnetic ores. The principal instruments now are those of Bavin, Siemens, Edison, and Wassermann. The other machines worked by passing the ore into or over several magnetised cylinders, each of increasing magnetic power, so that the particles of ore to be detained would be caught and held in their passage, leaving the others to escape.

Edison's ore separator allowed the ore to fall from a funnel, whose orifice throws it into a line shape in a fine stream, passing by magnets on its descent through the air, so that the magnets draw the particles attracted sufficiently out of a right line to cause them to fall on one side of a partition between two bins, while the dross and particles containing no iron fall into another.

A second mechanism, carefully and technically described by Von Urbanitzky in the same work (pages 276—284), is Edison's dynamo-electric machine, for generating the electric force required for sixty incandescent lamps of sixteen candles each; also the machine for 250 lamps of sixteen candles each, and the 1,000-light machine used for the lighting of stations. The total weight of the 1,000-light machine is over seventeen tons, of which ten tons go to form

the enormous electro-magnets, and 2·5 tons to the armature. This machine is in use at the Grand Central Depôt in New York, and is capable of lighting up a moderate sized park or small town.

The principle involved in these machines is so simple that Von Urbanitzky (p. 324) states it in a single sentence, thus—

"In all machines (dynamo-electric) the generation of electric currents is effected by the wires not containing currents, and magnetic fields, constantly changing their relative positions, by means of one portion of the machine (armature or electro-magnets) being kept in motion. In all dynamos, either the bobbins move in the presence of magnetic poles, or magnets move in the neighbourhood of coils in which currents circulate."

In short, the efficiency of electric generation is proportionate to the rapidity and power with which susceptible substances, or substances capable of rapidly receiving and parting with electric influence, are subjected alternately to the influx and efflux of that influence. A dynamo-electric generator may therefore be roughly defined as a machine in which electric energy is manufactured by the most rapid alternation of successive opposite currents through the same media, or by subjecting the same media to opposite electric conditions in most rapid succession, the power of the machine being proportionate to the dimensions of and number of the media in which the

alternation goes on, the intensity of the currents, and the rapidity of the alternation.

By a regular series of initiative steps, each of which is an independent evolution of man's inventive intellect, the discovery that a magnetised horseshoe, or a piece of iron or steel in horseshoe form, would lift a piece of steel or iron placed across its aperture, has led up to the generation of a force which will light up the largest city squares at night from a single cluster of burners, with a light many times more intense than could previously by any known means be imparted to a small room.

The first and simplest magneto-electric machine was that of Pixii in 1832, which simply caused a single horseshoe magnet to rotate so that its two arms should alternately come into contact with two soft iron cores at rest, around which coils of wire were wound through which a current was passing. Ritchie, Saxton, Clarke, and Siemens followed with improvements, each increasing the power of the current or regulating its intensity. At first each machine consisted of a great collection of permanent magnets, placed in revolution, in such manner that cores of soft iron were rapidly subjected to contact with them. The dynamo-electric machine came into being when it was discovered that for the generation of currents by magneto-electric induction it is not necessary that the machine should be furnished with permanent magnets. The residual or temporary magnetism

of soft iron quickly rotating is sufficient for the purpose. In 1867 Dr. C. W. Siemens and Sir Charles Wheatstone simultaneously read before the Royal Society papers on the "Conversion of dynamical into electrical energy" (motion into electricity) "without the aid of permanent magnetism."

Soon after Dr. Werner Siemens perfected his machine for generating electric energy without permanent magnets. Among the most noted of the magneto-electric and dynamo-electric machines have been the Alliance, which, as modified by Van Malderen, were used in the electric lighting on Mont Valerien and Mont Martre during the Siege of Paris in 1871, and have been used in some lighthouses on the coast of France ever since that date. This was about the time when Edison was getting well at work in his electrical instrument factory at Newark. But the form of the Alliance machine is complicated and costly, and it is not easily repaired when any part is injured. Then followed De Meritens' machine, which was the most efficient of any that used permanent magnets, and is still largely used in lighthouses. By this time, however, the continuous current dynamo-electric machines were developed, and Gramme, Schuckert, Gülcher, Fein, Brush, Bürgin, Schwerd-Scharnweber and Hochhausen, Alteneck and Siemens, Weston and Elphinstone and Vincent each carried the idea nearer to success by their respective inventions.

The Excelsior Electric Company of New York

constructed machines on the Gramme principle, which found favour in America.

When Edison went to work at the electric dynamo, or generator of electric force, too much had been done to admit of his doing much pioneer work. His proper mission was to perfect, and this, where so many intense and burning intellects had been directed into the same field, was the more difficult of the two. His labours were directed to removing from the dynamo all surplus wire not useful for purposes of generation; to avoiding unnecessary internal resistance in the machine, and the consequent excessive accumulation of heat; to such a construction as would facilitate repairs; to lessen the required use of insulated wires, which were costly and generated heat, &c. In a word, Edison's share in perfecting the electric light process involved the most minute investigations into, and comparison between, the experiments of all preceding inventors, combined with a genius for rapid invention and facile advance in every line of electric skill, which should utilise and save all of value which each had done, yet cap and eclipse them all. This he has done so effectually that the very words "Electric Light" must stand for ever as closely associated with the name of Edison as is gravitation with Newton, or the telescope with Galileo.

Simultaneously with the evolution of the dynamo for generating electric power it was necessary to perfect the glow lamp, or incandescent lamp.

Two methods have from the first been in use for producing electric light, viz., the arc and the incandescent. The voltaic arc is the passage of electric sparks or pure lightning between two separated carbon points—*i.e.*, points not united by a conductor. Davy produced the arc light in 1810, using charcoal enclosed in a vacuum. Foucault in 1844 followed, using carbon from the retorts of gasworks, which is much harder and less easily consumed. As early as 1844–5 the Place de la Concorde, Paris, was lighted by an arc light fitted up by Delénil. In 1858 Jobart proposed to make use of small carbon in a vacuum, and in the same year F. Moleyns, of Cheltenham, patented a lamp which sent the illuminating current through a glowing platinum spiral covered with coal-dust. In 1859 Dumoncel experimented with carbon filaments of cork, sheepskin, &c. In all cases to produce the electric light the electric energy has to be converted into heat. In the arc the circuit is broken, and the electric current passes through a vacuum. In the incandescent lamps it passes through a bad conductor or substance of high resistance, such as carbon at a white heat. Both lamps produce the light by concentrating resistance to the passage of the electric current.

Edison's first glow lamp used platinum wire. After experimenting in many substances for producing the carbon filament, he finally fixed upon bamboo fibre. The bamboo is first by machinery divided into

fibres of one millimetre in diameter and twelve centimetres in length. These fibres are pressed into U-shaped moulds, which are put by thousands into ovens, where they are carbonised. The carbon filament is attached to a platinum wire, which is placed inside exhausted glass vessels. Even the method of exhausting these vessels was devised by Edison, as also the key for turning the lamps on and off, the regulator for adjusting the intensity of the light, and the bracket for attaching it. The free ends of the platinum wires are set in copper sockets, which are insulated by plaster of Paris. Among the many competitors with Edison in maturing the glow lamp were Swan, Maxim, Lane-Fox, Siemens Brothers (of Charlottenburg, near Berlin), Cruto, Bernstein, Böhm, Diehl, Hamond, Töpler. Besides these, half-incandescent lamps—*i.e.*, half glow and half arc—have been constructed, in which the electric energy is sent through a series of partial conductors, and the light is produced at the place of contact between the two conductors, one of which is consumed in the process. Such are Werdermann's, Varley's, Reynier's, Markus', Brougham's, Ducretet's, Hauck's, and Jöel's. Besides these are a dozen varieties of the arc lamp, and finally several forms of electric candles.

The chief problem in the distribution of electric light is to divide it without loss of energy. At present gas has the advantage over electric light, that it can be conveyed and divided among many

consumers without any appreciable loss whatever. In subdividing the electric light, the greater the partition the greater the loss, no matter how carefully the leads are carried out. It is most suitable, therefore, in its present stage of evolution, to occasions where great intensity of light is required, with but little distribution. Among these are public squares of cities, theatres and public buildings, steamships, and mines. Within twenty-five years 290 theatres have been burned, involving a cost of 37,500,000 dollars.

The first large theatre lighted by the electric light was the Savoy, in London; then followed the theatre at Brünn, whose plant was furnished in part by the Société Electrique Edison, of Paris. The apparatus contains four Edison and three Gramme machines, the former lighting 1,000 Edison lamps, each of 16-candle power. In the apparatus used for lighting the theatres at Munich and Stuttgart there is a contrivance by which a sudden flash is effected, imitating lightning. Also Edison has here devised a system by which to avoid danger from the heat incident to the sudden extinguishment of a great number of lamps at once; the attendant is automatically informed of this, and by help of a rheostat remedies the difficulty.

The central station at Strasburg is fitted up by the Alsace Electric Company with fourteen continuous-current electric machines for feeding sixty arc lamps, and four Edison machines, three of which feed

250 lamps each, and one feeds 450 Edison lamps. The printing-office of Jaenecke Brothers, in Hanover, is fitted up with the Edison light, as is also the *New York Herald* Office, and its proprietor's steam yacht, *Namouni.* The largest central station for electric lighting is that at New York, managed by Edison.

CHAPTER V.

THE MAN OF GENIUS BECOMES THE MAN OF FORTUNE.

WITHIN ten years from the date when Edison reached New York—a battered adventurer, but without a vice, a roving tramp bearing many scars of failure, but none of dishonour—he had not only obtained world-wide recognition of his genius as an inventor, but he had earned as profits, and expended upon his inventions, half a million of dollars (about £100,000). Professor Barker styled him "a man of herculean suggestiveness: not only the greatest inventor of the age, but a discoverer as well; for when he cannot find material with the properties he requires, he reaches far out into the regions of the unknown, and brings back captive the requisites for his inventions."

At this period, among his American patents, says

McClure, thirty-five pertained to automatic and chemical telegraphs, eight to duplex and quadruplex telegraphy, thirty-eight to printing telegraph instruments, fourteen to Morse's telegraph proper, with a considerable residue relating to fire-alarms, electrical signals, district and domestic telegraphy, the electric pen, the phonograph carbon, carbon telephone, Tasimeter, microphone, aërophone, electric light, and a great variety of electrical and non-electrical apparatus. The variety and number of his inventions attracted the attention of the humorists. Burdette, of the *Burlington Hawkeye*, perpetrated the following description of a new Edison Spanktrophone :—

"We remember meeting Mr. Edison, some years ago, when he was most deeply absorbed in his experiments relating to the conductibility of sound through the various mediums, and had a long and interesting conversation with him upon that subject. We conversed upon the well-known fact that the same medium of transmission has different properties at different times. We both cited instances in which a man forty-three years old, though using his utmost strength of lung and voice, could not shout loud enough, at 6.30 in the morning, to awaken a boy nine years old just on the other side of a lath and plaster partition, while at 11 o'clock that night the same boy would hear a low whistle on the side-walk, through three doors and two flights of stairs, and would spring instantly out of a sound sleep in response to it. It was a belief of

Mr. Edison's, at that time, that sound could be made to travel as rapidly as feeling, and to test the matter he had invented a delicate machine called the spank-trophone, which he was just about trying when we met him. We were greatly interested in the machine, and readily agreed to assist in the experiment. By the aid of Mr. Edison and a street-car nickel, we enticed into the laboratory a boy about seven years old. After many times reassuring him and promising him solemnly that he would not be hurt, we got the machine attached to him, and the great inventor laid the boy across his knees in the most approved old-fashioned Solomonic method. On a disc of the machine delicate indices were to record, one the exact time of the sound of the spank, the other the exact second the boy howled. The boy was a little suspicious at this point of the experiment, and with his head partly turned, was glaring fearfully at the inventor. Mr. Edison raised his hand. A piercing howl rent the air, followed by a sharp concussion like the snapping of a musket cap, and when we examined the dial-plate of the machine, infallible science proudly demonstrated that the boy howled sixty-eight seconds before he was slapped. The boy went down-stairs in three strides, with an injured look upon his tearful face. Mr. Edison threw the machine out of the window after the urchin, and we felt that it was no time to intrude upon the sorrows of a great soul, writhing under a humiliating sense of failure. We have never met Mr.

Edison since, but we have always thought he didn't know much about boys, or he would know how utterly unreliable the best of them would be for a scientific experiment."

The same paper goes on to say: "In the course of human events, Eli Perkins would naturally meet with Mr. Edison. On one occasion, according to E. P.'s version, the interview was as follows:—

"It pains me to hear of so many people being burned on account of elevators, and defective flues. To-day Professor Edison and I laid a plan before the Fire Inspectors which, if carried out, will remedy the evil.

"When I called on Professor Edison at Menlo Park, he was engaged on a new experiment. He was trying to abstract the heat from the fire, so as to leave the fire perfectly harmless, while the heat could be carried away in flour-barrels to be used for cooking. Then the Professor tried experiments in concentrating water to be used in the engines in case of drought. The latter experiment proved eminently successful. Twelve barrels of croton water were boiled over the stove, and evaporated down to one, and this was sealed in a small phial, to be diluted and used to put out fires in cases of drought, or in cases where no croton water can be had. In some cases the water was evaporated and concentrated till it became a fine dry powder. This fine dry powder, the Professor tells me, can be carried around in the pockets of the firemen, and be

blown upon the fires through tin horns—that is, it is to extinguish the fire in a horn.

"I examined the Professor's pulverised water with interest, took a horn—in my hands—and proceeded to elucidate to him my plan for constructing fireproof flues. I told him that, to make fireproof flues, the holes of the flues should be constructed of solid cast-iron, or some other non-combustible material, and then cold corrugated iron, without any apertures, should be poured around them.

"'Wonderful!' exclaimed Professor Edison in a breath; 'but where will you place those flues, Mr. Perkins?'

"'My idea,' I replied, drawing a diagram on the wall-paper with a piece of charcoal, 'is to have these flues in every instance located in the adjoining house.'

"'Magnificent! but how about the elevator?' asked the Professor.

"'Why, after putting them in the next house, too, I'd seal them up water-tight, and fill them with croton, and then let them freeze. Then I'd turn them bottom side up, and, if they catch fire, the flames will only draw down into the cellar.'

"Professor Edison said he thought my invention would eventually supersede the telephone, and do away entirely with the necessity for the Keely motor!"

"Mr. Edison at this time," says one of his co-labourers, "averaged eighteen hours of labour a day. I have worked with him for three consecutive months

all day and all night, except catching a little sleep between six and nine o'clock in the morning." On one occasion, while developing the automatic telegraph, he needed a chemically-prepared paper on which more than two hundred words a minute could be recorded. Certain French solutions already known were adequate to prepare paper to that limit, but he had invented an instrument which would record more, and he must have the paper to fit the machine. Edison had ordered a pile of chemistries five feet high, from New York, London, and Paris. As usual, when hard at work he seldom slept, and did not go at all to his house, though it was but a few rods away. His meals were brought to him. He ate at his desk, and slept in his chair. The study occupied six weeks. In this period he went through every volume, had written another considerable volume of extracts, had made two thousand experiments, and had invented the required solution, which would record over 200 words a minute over a wire 250 miles long. He has since increased this to 3,100 words a minute.

Well might a leading American journal say—"There can be no doubt that Mr. Edison, the inventor of the phonograph, is one of the most remarkable men of the present century. His improvements in telegraphic apparatus, and in the working of the telephone, seem almost to have exhausted the possibilities of electricity. In like manner the discovery of the

phonograph and the application of its principles in the ærophone, by which the volume of sound is so amplified and intensified as to be made audible at a distance of several miles, seem to have stretched the laws of sound to their utmost limit. We are inclined to regard him as one of the wonders of the world. While Huxley, Tyndall, Spencer, and other theorists talk and speculate, he quietly produces accomplished facts, and, with his marvellous inventions, is pushing the whole world ahead in its march to the highest civilisation, making life more and more enjoyable."

Mr. Edison could not, however, accomplish all his labours by any degree of individual effort. In nearly all intellectual labour it is essential to the highest success to know how to organise and make use of the labour of others. Humboldt, Cuvier, Darwin, and Newton illustrated this truth in the walks of Science. Herbert Spencer, with his corps of assistants, exhibits it in Philosophy. Hubert H. Bancroft, the historian of the Pacific Coast, with his equally well-organised corps of aids, illustrates it in History. The late Samuel J. Tilden proved it in Politics. Story and Chitty shone by its reflected light in legal authorship and jurisprudence.

No master-workman living understands better than Edison the high art of organising a staff of competent assistants and culling out a force of efficient subordinates. Without this skill in commanding the labour of others he could not, as he in fact frequently

does, conceive an invention in the morning and receive a working model from his chief assistant before night. This chief assistant, Mr. Charles Batchelor, has been with him since 1870, and has helped to perfect most of his inventions. He has charge of eleven skilful machinists and instrument makers. Professor McIntyre, with two assistants, has charge of all ordinary researches in chemistry. Mr. L. F. Griffin, his private secretary, a former telegraph operator, has charge of his immense correspondence, and of the more confidential financial matters; he has also a book-keeper and a master machinist. All these receive stated salaries, except Mr. Batchelor, who has an interest in his inventions.

No eight-hour law applies or is desired in Mr. Edison's establishment. He has placed himself in a position where he could make his hours as short as he desired by first making them as long as the nature of his work demanded. More of his inventions are now in use, and more of those in use pay a profit, and the aggregate of the profits on his inventions, as such, is probably larger than those of any other inventor as such. He enjoys an income from royalties and otherwise about equal to that of a President of the United States, and continually increasing.

In his laboratory he is slouchily dressed, with no taste for anything but hard work, deep study, and profound investigation. He cares nothing for the neat ways of dress and personal outfit which mark

the man of business who has occasion to meet and deal with men superficially. In his laboratory he looks like a deeply-absorbed workman. His garments are acid-stained, his hands and face discoloured and dusty, and his hair dishevelled. The barber, tailor, and bootblack are things he has no time for. To his friends and companions he is still Tom, just as he was before his fame and wealth came to him. Public dinners and speeches in his honour are bores to which he will not, even for a single occasion, submit. No money would buy him to go where he would hear vapid praises of his merit from that toady class who always wait to place their legs under the mahogany of acknowledged success. Mr. and Mrs. Veneering could in no way induce him to attend their dinners. He has no taste for watering-place loungers and society hunters.

On a happy day in 1873 his attention was attracted to a young lady of very perfect features, and studiously careful habits of work, who was manipulating a machine he had invented for electric writing by means of perforations in paper. The young lady was determined not to look up, and her admirer was curious to know why she shrank so demurely from meeting his eye. In some way the two kinds of magnetism came into conflict with each other, the message which was being transmitted to the young lady's mind through the persistency of the inventor's stare at her tremulous fingers intercepted

the message which she was endeavouring to impart to the perforated paper. The entanglement confused her, and she was obliged to stop.

"What scares you, little girl?" said Edison, smiling; "are you afraid of me?"

"Oh, no, sir; not in the least—but—that is——"

"Then you dislike me, or like me—which?"

"Why, of course, I like you—I mean it is not dislike, you know, that frightens me. It is—that is—it is——"

"Well, never mind explaining now—we can find out some time. In the meantime will you marry me?"

This was electric speaking indeed. The young lady, at Edison's request, consulted her mother. Shortly afterward an intimate friend, seeing a light burning in Edison's laboratory after midnight, came in and found him so absorbed in his experiments that he seemed almost unconscious of the world around him.

"Tom," said he, "it's after twelve. Aren't you going home to-night?"

"Twelve! twelve!" replied Tom, waking up from his reverie. "Twelve! By George! Now I think of it, I was married to-day. I must go home, sure!"

Soon afterward the young couple removed from Newark, where they had been married, to Menlo Park. One of their children is named Mary Estelle, and the next Thomas Alva Edison, Jun. But somehow

Edison's old habits as an operator cling to him. He had been so long at work using the Morse alphabet, which consists wholly of the "dot" and the "dash," that he fell into the habit of calling his little girl "Dot," and his boy "Dash." Those are their pet names yet.

He removed to Menlo Park in 1876, where he fitted up the most completely appointed laboratory and machine-shop for the manufacture of models in the world. The cost of the experimental apparatus was upwards of one hundred thousand dollars.

Throughout all this career of good fortune Edison's industry caught a new and more fertile inspiration with every improvement in his opportunities. His inventions came faster than ever.

CHAPTER VI.

THE TELEPHONE—THE PHONOGRAPH—THE TASIMETER—ELECTRO-MOTORS—THE FUTURE OF ELECTRIC DISCOVERY.

IN his invention of the carbon telephone, Edison has as forerunners, rivals, competitors, or imitators, a host of inventors. The first discovery leading toward the telephone was made by Page, in 1837, that an iron jar when magnetised and demagnetised at short

intervals emits sounds. On the basis of this fact Reiss, in 1861, exhibited to the Physical Society of Frankfort the first telephone. By the rapid magnetisation and demagnetisation of an iron wire he produced sounds having the same rate of vibration, and therefore the same pitch, as the note sung into the transmitter. He claimed also to have transmitted distinguishable words. S. Yeates, Wright, Varley, C. and L. Wray, Elisha Gray, Vanderweyde, Pollard, and Garnier, all laboured to advance the telephone from the stage reached by Reiss, of transmitting vocal sounds, so as to preserve their volume and pitch, to the point of transmitting them with the articulation and other details which make them words. Reiss's first experiment is said to have been made with a transmitter constructed out of a beer barrel, and receiver modified out of a violin. In his more advanced instrument A. Graham Bell, while teaching the deaf and dumb at Boston in 1859 to 1861, was led to the discovery of some of the modes by which the transmission of sound may be aided by electricity. This led to his production of two forms verging toward the telephone. In 1876 Bell exhibited his third telephone at Philadelphia. Then followed Berliner with the microphone, Hughes, Siemens, Gowers, Fenis, Aders, D'Arsonval, Bootcher, Phelps' crown telephone, Phelps' Pony telephone, Gray's telephone, and Edison's carbon telephone and chemical telephone. Few of these inventions were

simple or single. All involved numerous points. Edison was the first to discover the superiority of carbon as the central medium of contact and transmission. But numerous other details of the telephone are the children of his brain.

The phonograph makes no use of electricity, but is one of Mr. Edison's most interesting inventions. It is a revolving cylinder, into which vocal sounds uttered or sung are so registered for reproduction and distribution, that the sheets whereon these are registered may be subsequently used to reproduce the tones in the very voice, tone, strength, volume, emphasis, inflection, and accent with which they were uttered. In describing the uses of this instrument, Mr. Edison himself is quoted as saying:—

"*First.*—For dictating it will take the place of shorthand reporters, as thus: A man who has many letters to write will talk them to the phonograph, and send the sheets directly to his correspondents, who will lay them on the phonograph and hear what they have to say. Such letters as go to people who have no phonographs will be copied from the machine by the office boy.

"*Second.*—For reading. A first-class elocutionist will read one of Dickens's novels into the phonograph. It can all be printed on a sheet ten inches square, and these can be multiplied by the million copies by a cheap process of electrotyping. These sheets will be sold for, say, twenty-five cents. A man is tired, and

his wife's eyes are failing, and so they sit around and hear the phonograph read from this sheet the whole novel with all the expression of a first-class reader. See? A company for printing these is already organised in New York.

"*Third.*—It will sing in the very voice of Patti and Kellogg, so that every family can have an opera any evening.

"*Fourth.*—It may be used as a musical composer. When singing some favourite airs backwards it hits some lovely airs, and I believe a musician could get one popular melody every day by experimenting in that way.

"*Fifth.*—It may be used to read to inmates of blind asylums, or to the ignorant, who have never learned to read.

"*Sixth.*—It may be used to teach languages, and I have already sold the right to use it to teach children the alphabet. Suppose Stanley had had one, and thus obtained for the world all the dialects of Central Africa!

"*Seventh.*—It will be used to make toys talk. A company has already organised to make speaking dolls. They will speak in a little girl's voice, and will never lose the gift any more than a little girl.

"*Eighth.*—It will be used by actors to learn the right readings of passages. In fact, its utility will be endless."

Two days before the occurrence of the eclipse of

the sun (total among other points in Wyoming Territory), on July 9th, 1878. Mr. Edison invented and completed the construction of a tasimeter for detecting and measuring the heat of the sun's corona, of the moon, if any, and of the stars. In the course of his experiments leading to the invention of the carbon telephone, he had found that carbon was subject to expansion and contraction under conditions of electric influence and pressure, and also of heat and moisture, with a sensitiveness which, when made to govern the movements of a needle over a finely-graduated scale, would render it the best of all media for measuring all these conditions, and particularly heat. When tested even by bringing it into the field of so faint a heat influence as that of the star Arcturus, five uniform and distinct deflections of the needle were obtained from the instrument accordingly, as the light of the star were allowed to fall upon it, or were screened from it.

In its first use at the eclipse of 1878, Edison went with it in person, and set it up at Rawlings, in Wyoming. His extemporised pedestal was, in fact, a hen-house, and not the most advantageous base on which to measure the heat of the sun's corona. A stirring wind was blowing at the time, and the hen-house was too susceptible to these gusty movements of the air to admit of accurate work at the instant. Moreover, he found the heat of the corona so excessive that his tasimeter proved to be adjusted ten times too

sensitively. The heat from the corona went entirely beyond the index capacity of the instrument, and before he could re-adjust it the eclipse had ended.

Mr. Edison describes the principle of the tasimeter as follows :—" It consists of a carbon button placed between two metallic plates. A current of electricity is passed through one plate, then through the carbon, and through the other plate. A piece of hard rubber or of gelatine is so supported as to press against these plates. The whole is then placed in connection with a galvanometer and an electric battery. Heat causes the strip of hard rubber to expand and press the plates closer together on the carbon, allows more current to pass through, and deflects the needle of the galvanometer. Cold decreases the pressure. Moisture near the strip of the gelatine can be measured in the same way by increasing or decreasing the pressure, and accordingly deflecting the needle. By means of this apparatus, or one combined with sensitive electrical galvanometers, it is possible to measure the millionth part of a degree Fahrenheit."

As respects motors, the name of Edison is as yet associated only with those which transmit and apply electricity. One of these is his electric pen, which writes by perforating paper with small holes made by a needle, which works by electric force with great rapidity. As respects the motors for generating power electrically, a word of caution by Von Urbanitzky in the work from which many of our facts are

taken may be instructive. He says (Cassell's edition, p. 658) :—

"Heat acts by expansion of volume (which is necessarily a wasteful principle), while electricity operates by attraction and repulsion, a mode that is subject to no greater loss of effect than attends the action of gravity in a hydraulic machine. If, then, we could only produce electricity with the same facility and economy as heat the gain would be enormous; but at present the cheapest way of generating electricity is by the dynamic process. Instead of beginning with electricity to produce power, we have at present to begin with power to produce electricity. We know of no source from which we can obtain a supply of electricity sufficiently cheap and abundant to enable it to take the place of heat as a motive energy. We obtain the supply of heat from combustion or the consumption of fuel in its union with oxygen, and we probably cannot expect to find other bodies capable of yielding energy by a cheaper process. We cannot get energy of affinity where affinity has been already satisfied, and the bodies composing the mass of our globe are in combination already. We might as well try to make fires of ashes as to use such bodies over again as sources of either heat or electricity. The only abundant substances in nature possessing strong unsatisfied affinities are organic bodies and coal. Until some means be found of making the combustion of coal available for producing

electricity directly we cannot hope to obtain electricity at such a cost as to supplant heat as a motive agent. It is therefore as secondary motors (for the transmission of power) and not as primary motors that we may expect electric engines to play a more important part in the future."

Yet right in the face of this authoritative prophecy that electricity cannot be used economically as an originator of motive power, a writer in the *New York Sun*, apparently well informed, says :—

"The revival of interest in the electric motor during the last year causes it to seem like a new invention to those not familiar with the record of electrical science. As a matter of fact, the electrician, Jacobi, under the patronage of the Czar of Russia, propelled a boat on the Neva by electricity about fifty years ago; and not many years later Prof. Page, in this country, succeeded in driving a car by an electric locomotive between Washington and Bladensburg at a speed of nineteen miles an hour. But nothing resulted from these early experiments, on account of the rudimentary methods of generating electricity; and had not the electric light been made commercially successful the motor would still be floating in the brain of scientists as a future but very indefinite possibility. Now, however, it has been caught and made objective. Thousands of electric motors are at work in various parts of the country, ranging in capacity from one-half to twenty-horse power, and they are

transferring freight and passengers, running printing presses, lifting elevators, driving ventilators, and making themselves generally useful at domestic and industrial service. A single company reports the manufacture and sale of 150,000 dollars worth of the motors within a month.

"The adaptability of the motor for operating street railways is the problem now puzzling the American people. Being entirely noiseless, perfectly clean, susceptible of being started, regulated, or stopped by the mere pressure of a button, and cheap, both in constructing and operating, its utility for the lighter kinds of industrial service is beyond question. But nothing in the form of a motor can satisfy the average American, never more than half a citizen, except when on wheels, unless it can be made to transport passengers, and so all the experiments in the railway field are being watched with a great deal of interest. From the experiments already made we have every reason to be hopeful.

"It may sound a little curious to any old soldier who did some of his campaigning in the Gulf States during the war to be told that Montgomery, Ala., is the leading city in the Union in electric railway transit. It is the fact, however, and over her road, eleven miles in length, nearly twice the length of any other electric road in the world, are transported 1,000,000 passengers a year. This is a number far in excess of the number carried by any other road of its kind in

this country, and equal to the number transported on any European road. The general manager of the Montgomery road reports its operating expenses at fifty per cent. less than the cost of horse or mule traction.

"Next, at Denver, Col., we find a three-and-a-half mile track, over which are transported 500,000 passengers in a year, at a cost of one dollar fifty cents a day for fuel. At Appleton, Wis., there is a four-and-a-half mile track, serving 400,000 passengers annually, and the cost for power is limited to the wages of one man, who tends a water-wheel. There is also a road at Baltimore, one at Los Angeles, Cal., another at Port Huron, Mich., two at Detroit, one at Scranton, Pa., and one at Windsor, Canada. These roads serve from 200,000 to 300,000 passengers. There are also about twenty electric roads now under construction in different cities or towns throughout the Union, and nearly forty new companies have been formed, or are in process of organisation.

"It may be said that, judging from the reports, all the electric roads are operated at low cost. A temporary road about one mile long was operated at Toronto, Canada, during the exhibition in that city. The number of passengers carried averaged 10,000 a day, and the consumption of coal reached only 1,000 lbs. As to the capacity for heavy work on the rail, it may be stated that a sugar refinery at Boston has in constant use a train of cars propelled by an electric motor which carries thirteen tons per trip.

"For street traffic much is expected from storage batteries. Accumulators were used experimentally in England as long ago as 1883, and a car operated by this agency cost only one dollar fifty cents a day, where the previous cars with horse traction had been six dollars twenty-five cents a day. The accumulators are securely packed under the seats in a manner to cause no loss of space, and are replaced when exhausted almost as quickly as a change of horses can be effected. The new Beacon Hill road, now being constructed in Boston, is to be operated by accumulators, and it is expected that this means of supplying power will soon be brought into very general use."

Mr. Edison many years ago had constructed a novel electrical engine which he called the "Harmonic." With two small electro-magnets, and three or four small battery cells, enough power was generated to drive a sewing-machine, or pump water for household purposes. It was similar in principle to the electric motors constructed by Deprez, Trouvé, and Griscom, which also were capable of driving sewing-machines, and similar light work. The following popular description of the principle of the new electric motors may suffice for those who have not the technical skill to apprehend a more exact or detailed presentation. The writer says:—

"In some of the earlier motors the circumference of a smaller wheel, say two inches in diameter, and operated by the larger wheel, was composed

of alternate sections of a conducting and non-conducting material, and on the surface of this wheel lay the point of a metallic finger. When this finger rested on a conducting section the electric circuit was formed, and the current passed through the magnet; but the instant it touched a non-conducting section the current was broken. These conditions being prepared, start the larger wheel while the point of the metallic finger is resting on a conductor. The current will then flow around the magnet, and instantly the nearest armature, feeling the impulse of attraction, will rush toward the point of contact. But directly on its approach the finger reaches a non-conducting section of the smaller wheel, and the current ceases. The deluded armature, no longer under the influence of attraction, flies onward impelled by its own momentum, and allows the joke to be played on the next armature coming up from below. As soon as the connecting finger touches another conducting section, this second armature repeats the effort of its predecessors with equal but with not any better success, and, after failure, relinquishes the field to the third armature. And so the play goes on until the wheel, continually gathering momentum from momentum, flies like a revolving saw. Provided with proper gearing, and graduated in size to adapt it to the labour to be performed, it is strong enough to turn ponderous machinery, or lift tons upon tons."

These hints may or may not indicate the direction in which the immediately impending advances in electrical discovery may be made. Scientific progress generally pursues a route of its own, diverging at many points, and differing in many results from that marked out and surveyed for it by its pioneers. Whatever may be its trend or line of development, it will stand closely associated with the labours of the faithful and brilliant worker, the chief outlines of whose life and character are sketched in these pages. The life is instructive. The character is unique and pleasing. The former is, perhaps, but half spent. The latter blushes modestly, and shrinks almost from the necessity of being known by the usual methods, or in the ordinary way. Enough, however, of both have transpired to ensure that on the same scroll of fame which holds the names of the world's first electric discoverers and inventors, of Franklin and Morse, must follow with even a brighter lustre than either—the name of Edison.

SAMUEL FINLEY BREESE MORSE.

CHAPTER I.

THE PLANTING OF THE IDEA.

ELECTRICITY is identified with Benjamin Franklin. Electricity and telegraphy are both identified with Samuel Finley Breese Morse. To one we are largely indebted for the printing-press, the lightning-rod, the almanack, and the postage stamp. To the other, for the perfecting of the most wonderful invention of the nineteenth century, the invention that has wrought the greatest change in methods of transmitting intelligence.

Franklin wished that he might see what would come to pass in one hundred years or more, a few of the fruits of the discoveries of his day. He little dreamed what his kite-flying and studies in electricity would bring to pass. We are partially enabled to realise the progress of the last one hundred years, when we recall the fact that when Franklin died in 1790, it must have taken more than a year for the news of his death to reach many parts of the globe—those foreign cities where he was well known, and where news from the United States

was eagerly looked for. When Professor Morse died in 1872, the round world knew it in a flash. The idea of the telegraph—"talking at a distance"—had been growing in men's minds for ages. It had grown wonderfully in Franklin's brain; but until Morse gave it long years of study, it was like the lily bulb under the snow.

Franklin was a Boston boy, and so was Morse. The birthplace of each was in the locality of Breed's Hill. Franklin had been dead a little more than a year when the child was born who was to take up the unfinished studies of the American philosopher, and help answer the hard questions concerning electricity. Nor will it do to pass unnoted the fact that the mother of this child was born "not a stone's throw" from where the first telegraph office was opened in New York City. There is nothing on record showing that the boy, born April 27th, 1791, was in any way a phenomenal infant. We do know, however, that the letter telling his grandmother in New York of the arrival of Samuel Finley Breese Morse was at least three days in transit, and that the postage on the same could not have been less than twenty-five cents. He, of all the babies born in Boston that year, deserved the expenditure, seeing he had come to work a reformation in the transmisson of news.

At that time, they tell us, a Londoner of quality could not send a letter to Edinburgh and get an answer in less than three days, and then only if

weather and highwaymen permitted. Postriders left London for Edinburgh with five or six letters at the most, and not unfrequently with only one. True, the Americans had shown great enterprise in their Flying Machine—a covered Jersey waggon without springs, which could *fly* from New York to Philadelphia in three days—but, as a rule, babies born at long distances from their grandmothers were likely to become quite venerable before their advent was properly appreciated.

Samuel Finley Breese Morse had a Princeton College President for his great-grandfather. His father was a clergyman, and the well-known "Morse's Geography" of that day was prepared by him. Not until Samuel was a schoolboy in petticoats did he do anything that has found a place in his biographies, and then he scratched with a pin on a bureau what he thought a good portrait of his crippled old school-teacher. It was the first sign of his genius as an artist, and cost him a sound whipping. That scratching, however, made the old bureau very valuable years after, for the boy went on making pictures, and showed a decided genius for art.

At fifteen he painted in water-colours a drawing of a room in his father's house, with the family around the table; and before he was nineteen he had finished the painting which used to hang in the Mayor's office of Charlestown, Massachusetts—"The Landing of the Pilgrims at Plymouth." He had already written a

Life of Demosthenes. There was nothing remarkable in the book itself, and his parents had common sense enough not to have it printed; but there was something remarkable in the fact that a boy of fourteen should be so studious and thoughtful as to write such a book, and yet not the least bit of a prig. He did not read many books, but he studied a few thoroughly. He did not read anything and everything.

He fixed his mind upon one subject, and studied it deeply. Love of Art made him something of a dreamer; love of Science saved him from mere dreaming. Science and Art together made his bright brain the soil needed for the perfection of an idea—the idea the world had been waiting for so long. Dreaming about an idea is one thing—working out an idea is another. Ideas find no root in the brains of mere dreamers.

The idea of the telegraph had been planted in young Morse's brain one morning in the class-room at Yale College, where he was a student nineteen years old. The lesson was upon Electricity, and Professor Day was the teacher. Why was it that only one student of that class caught the idea of the lesson? And yet so faintly did young Morse apprehend it, that years of hard study and patient labour were spent upon it before he could express its full meaning.

Wise men the world over were studying the science of Electricity. The idea of a practical recording telegraph was in many a mind, and Dr. Franklin among others had succeeded in sending an electric current

for some distance. Reid, in his admirable history of the "Telegraph in America," describes in full the experiments preceding the Morse invention, and the discoveries without which Morse had been defeated with the rest. Telegraphy, as we know it to-day, was an undiscovered science at the beginning of this century, and yet the telegraph was hidden in the words of the lesson which those Yale students recited that morning. These are the words that led young Morse to thinking it out, and which after weary years gave us the magnetic telegraph :—

"If the circuit of electricity be interrupted, the fluid will become visible; and when it passes, it will leave an impression upon any intermediate body."

How clearly the bright boys of to-day see the secret of the Writing Telegraph in that sentence. Not so young Morse. But he kept thinking about it. He read everything he could find upon the subject. He noted the experiments of experts in electricity—the attempts of inventors. "The fact," he wrote in after years, "that the presence of electricity could be made visible in any desired part of the circuit was the crude seed which took root in my mind, and grew into form, and finally ripened into the invention of the Telegraph." He attended lectures on his favourite science, made a speciality of chemistry and electrical experiments. Nevertheless, his ambition was to follow art, to paint pictures, especially portraits. His father was advised by the two leading artists of the day,

Stuart and Allston, to send the young man to Europe, that he might study under the famous Benjamin West.

His father was by no means a rich man, and studying abroad meant for Samuel severe economy and application. Experimenting with electricity was money out of pocket for a young man who had his bread to earn. Among the old letters found among Professor Morse's papers was one upon which he had, in his later years, written in pencil, "Longing for a telegraph even in this letter." It was the first letter he wrote to his parents after his arrival in England, and it is as follows—"I only wish you had this letter now to relieve your minds from anxiety, for while I am writing I can imagine mother wishing that she could hear of my arrival, and thinking of thousands of accidents which may have befallen me. I wish that in an instant I could communicate the information. But three thousand miles are not passed over in an instant, and we must wait four long weeks before we can hear from each other."

He was a favourite pupil of Benjamin West, and did honour to himself and to his master. His patience in detail was the secret of his success. He used to tell the story of a lesson his great master gave him, which he believed helped him in winning the victory of his life. He had made a small cast of Hercules as a test of his fitness for a place as student in the Royal Academy.

"Very well, sir; very well," said West, handing it back to him, "go on and finish it."

"It is finished."

But the master said, "No," and another week was spent on the cast.

"Very well, indeed, sir," said West, looking at it critically, to hand it back as before. "Go on and finish it."

Morse was well-nigh discouraged.

"But is it not finished?"

Patiently the defects were pointed out and admitted. Three days more of work on the cast.

"Very clever indeed," said West, "Now go on and finish it."

"I cannot finish it," was the quiet, decided reply, and then came the commendation for his skill and industry, which was never forgotten.

"Finish one picture, and you are a painter," said the master.

His clay model of the "Dying Hercules" carried off the prize of the Society of Arts, and the gold medal was conferred upon the young American before a distinguished company, while his colossal painting of the "Dying Hercules" had foremost rank in the exhibition of the Royal Academy. His "Judgment of Jupiter" would doubtless have won another prize, but his father had summoned him home, and the rules of the Academy required the presence of the victor. He had prolonged his stay by the practice of severe

economy. His letters had introduced him to the best men of England, and he was in constant intercourse with Benjamin West, Allston, Coleridge, Rogers, and others as eminent in literature and art. An American artist, so young, whose "Dying Hercules" merited a place among the nine best paintings in a gallery including works of Turner, Northcote, Lawrence, and Wilkie, must have been a notable personage in London Society, and yet we find him writing to his parents as follows:—

"With regard to my expenses, I got through the first year with two hundred pounds, and hope the same sum will carry me through the second. . . . I am obliged to screw and pinch myself in a thousand things in which I used to indulge at home. . . My drink is water, porter being too expensive. . . . I have had no new clothes for nearly a year. My best are threadbare, and my shoes are out at the toes. My stockings all want to see my mother, and my hat is hoary with age. . . . When I first came to London, I laid out a considerable part of my money on myself. Meanwhile picture-galleries and collections were neglected, because I could not afford it."

He was one of the guests at the dinner-table of the eminent philanthropist, Wilberforce, when the firing of the guns in Hyde Park announced the defeat of Napoleon at the Battle of Waterloo. That was in June, 1815, and in a few days after the artist Morse sailed from Liverpool for Boston, where he arrived

after a passage of fifty-eight days, and an absence of more than four years.

He returned from Europe a poor man, but a famous one. He was then about twenty-four years of age. He placed his "Judgment of Jupiter" on exhibition, and Boston society lionised him, and crowded to see his canvas. But nobody bought the picture, nor ordered another. Almost penniless, he went to Concord, New Hampshire, and there cabinet portraits brought him a fair support. He tried to improve his pecuniary affairs by inventing something, and we find him and his brother Sydney engaged in the manfacture and sale of a pump, which they playfully called "Morse's Patent Metallic Double-Headed Ocean-Drinker and Deluge-Spouter Valve Pump Box." But that was only another failure.

During his four years in Charlestown his affairs brightened somewhat, and in 1818 he went back to New England with three thousand dollars (about £600), and a wife. But his great exhibition picture of the "House of Representatives at the National Capitol" was a loss for him of time and money. Then we find him in New York again, founding the National Academy of Design, lecturing before the New York Athenæum, writing some, and painting pictures. New York City gave him an order to paint a picture of Lafayette, who was then the hero of the hour. But what was of most importance to the world, he attended Professor Dana's lectures on

electro-magnetism, and improved every opportunity to talk with Professor Dana of the possibilities of the "spiral voluto coil," which suggested to him the electro-magnet used to-day in the recording instruments of every Morse telegraph in the world. "How can electricity be made to write?" was still the question no one had answered.

One Harrison Gray Dyer, of New York, about this time (1827) had put up a line of telegraph poles on Long Island. "He used common, that is, frictional electricity," says Reid, "and but one wire, that operated by causing a spark, which, by passing through litmus paper, left a red mark upon it, and then passed into the ground without a return wire circuit. The difference of time between the sparks was by an arbitrary alphabet, to signify different letters. It was abandoned in 1830, but was the nearest approach to a recording telegraph yet invented." The difficulty was in the lack of a proper battery. Daniell's battery, without which, or one as good, Morse had been defeated, was then undiscovered. It is hard for us to believe that Dyer was frightened into fleeing from his country because of a writ against him for "conspiracy to carry on secret communications from city to city," but such is the fact.

Up to 1835 the two essentials for a recording telegraph were undiscovered, viz., the Daniell battery, which gave constancy and certainty to the magnetic current, and the Morse relay, by which the current

could be reinforced or renewed by its own action at any distance from its source. Those two inventions were indispensable for the actualisation of the Morse idea of a telegraph. These obstacles, and certain unformed ideas about a telegraph alphabet, had a place in our artist-inventor's thoughts when he started again for Europe in 1829, to study the old masters. As yet science had by no means displaced art in his affections. He sought out scientific men, in order to learn their ideas about "communicating intelligence between far-distant places, out of line of vision, by means of electro-magnetism." He spent some time in Paris, and painted another great exhibition picture of the interior of the Louvre—another financial failure he could ill afford. During his stay in Europe he was elected to the professorship of the literature of the Arts of Design in the University of New York.

In the month of October, 1832, we find the poor but famous artist on board the packet-ship *Sully*, bound from Havre to New York. He was forty-one years old, and fortune had given him no prizes other than a wide reputation as an American artist. The disappointments of his active, humble life had been many. The future was not so bright as it had been. He had recently met a bitter disappointment in not having been chosen to paint a picture for one of the vacant panels in the Rotunda of the Capitol of Washington, and he had reasonably expected that honour. He had gone aboard the *Sully* greatly depressed, yet

struggling against depression. No one was more cheerful and ready to do his part towards making the voyage a pleasant one, in the cabin at least. Had he been moodily brooding, shut apart in resentment, he might not have been of the little company discussing electricity one evening. A gentleman who had been attending scientific lectures in Paris was telling of the wonderful experiments he had seen with the electro-magnet, which he described, giving the length of the wire. Somebody asked if the velocity of the electricity was retarded by the length of the wire.

"Oh, no," was the reply, "it passes instantly over *any* length of wire."

The idea of a recording telegraph quickened in Morse's brain.

"If the presence of electricity can be made visible in any part of the circuit," he said, "I see no reason why intelligence may not be transmitted by electricity."

A new train of ideas was flashing through his mind. He withdrew, to think without interruption. He walked the deck alone until late in the night. He knew that the current of electricity would pass instantaneously any distance along a wire. If it were interrupted a spark would appear. Why not make that spark represent a part of speech, a letter, a number? Why not make the absence of the spark a part of speech; the duration of the absence a part? in short, why not have an alphabet, which should be the voice of electricity? Before the dawn he had made

such an alphabet in his note-book, almost exactly the same as that used in telegraphy to-day. The essential features of the original alphabet have never been superseded.

"Men can wink it with their eyes," says Reid, "can beat it with their feet, and dying men have used it to speak when vocal organs and the strength to write were exhausted. The prisoner can tap it on the wall or grating of his dungeon. Lovers in distant rooms can converse by it on the gas-pipe. Its uses are endless. It is the telegraphic language of the world."

MORSE'S TELEGRAPHIC ALPHABET.

The Telegraphic Alphabet represents each letter of the English alphabet, with the numerals, by which any amount of writing or correspondence may be conducted, in all the details of letters and words of the common mode of correspondence or writing.

"Morse did more than he knew," says a writer in *The Century*, "when he invented the alphabet of dots and dashes. The deaf mutes have adopted that alphabet with their finger-tips, and whenever they can touch each other with the hand they carry thought on the unbridgeable, unwireable distance lying between them and those that can hear."

During the remainder of the voyage he was working out his idea. He made drawings, which he showed to his fellow-passengers, who were interested in the subject, and in the vexatious litigations which he had

in after years, the testimony of those passengers in the Courts of Justice fixed the date of the invention of the Morse Electro-Magnetic Recording Telegraph in the autumn of 1832. He drew the model of a telegraph instrument and improved his alphabet.

"Well, captain," he said, cheerily, when they reached New York, "should you ever hear of the telegraph, remember that the discovery was made on the good ship *Sully*."

Alphabet.

A	- —
B	— - -
C	- - -
D	— - -
E	-
F	- — -
G J	— — -
H	- - - -
I Y	- -
K	— - —
L	———
M	— —
N	— -
O	- -
P	- - - - -
Q	- - — -
R	- - -
S Z	- - -
T	—
U	- - —
V	- - - —
W	- — —
X	- — - -
&	- - - -

Numerals.

1	- — — -
2	- - — - -
3	- - - — -
4	- - - - —
5	— — —
6	- - - - - -
7	— — - -
8	— - - - -
9	— - - —
0	———

CHAPTER. II.

THE SHAPING OF THE IDEA.

BUT he was still a long way from victory. His landing with that priceless sketch-book was followed by years of discouragement and seeming failure. Only that he had faith in the idea of his invention, and was ready to make any and every sacrifice for it, he would have cast it from him more than once as the crowning misfortune of his life. He believed that a recording telegraph was to be given to the world through him. The artist was now almost lost in the electrician. The sum of three thousand dollars, which his artist friends had subscribed, that he might paint the picture he had hoped to paint for the Rotunda—"The Signing of the First Compact on Board the *May-flower*"—was begun but never finished. His telegraph was first in his mind, and he could not paint; in 1841 he returned the money with interest. It took more than five years of hard study for him to complete his plan of an apparatus; and then by means of two instruments he could commmnnicate both from and to a distant point. The public were occasionally invited to the exhibition of his telegraph at the University of New York, and entertained as his friends were, they did not conceal their convictions that he was throwing away his time on a scientific toy. He went

before a Congressional Committee as early as 1832, and exhibited his apparatus, asking an appropriation for building an experimental line between Washington and Baltimore. He did not get it, but he petitioned for a patent for his invention, and he went to Europe to interest foreign governments in it if possible, and to get foreign patents. He came home burdened with disappointments and poverty. He had met in Paris, however, M. Daguerre, and the two great inventors of the age had shown their inventions and apparatus to each other, explaining the mysteries of each, and Professor Morse came home to complete his instructions in the wonderful art of taking daguerreotypes. "If my telegraph comes to nothing," thought he, "I must have something to fall back upon, for these daguerreotypes will make portrait-painting a poorer calling than ever." So he made a daguerreotype apparatus, and took the first daguerreotype ever taken in America. As the subjects were compelled to sit at least fifteen minutes in a glaring sunlight, the fact that they closed their eyes was reasonably excused.

In the winter of 1837-8 he was again in Washington, striving to interest the members of the two Houses of Congress in his invention. His apparatus consisted of two coils of wire, five miles each in length, forming a circuit of ten miles, insulated by a covering of cotton somewhat like ordinary bonnet wire connected at the end with a galvanic battery, and at the other with a

recording instrument of his own invention. The Congressmen enjoyed witnessing the experiments, but nothing came of it all, and he was painfully conscious of the ridicule his persistence was exciting.

He went back to New York, and hired a room at the corner of Nassau Street and Beekman, and there, in what was his studio, workshop, bedroom, and kitchen he lived alone through what he used to call the three black years of his life. He was determined to make a telegraph apparatus that would convince the world that electricity could write and transmit intelligence from distant points. He painted only enough to keep the wolf quiet within his door, for he could not shut him out entirely. He knew what it was to go hungry in those days, and to suffer from loneliness.

"I have not a cent in the world," he is writing to a friend near the close of 1841. To another he wrote as follows:—"I find myself without sympathy or help from any associated with me. For nearly two years I have lived on a mere pittance, and denied myself even necessary food, that I might have money enough to put my telegraph into such a position before Congress as to ensure its success. I am crushed for want of means. No one knows the days and months of anxiety and labour I have had in perfecting my telegraphic apparatus. For want of means I have been compelled to labour for weeks making with my own hands what could have been made much better in a tenth part of the time by a good mechanician.

Nothing but the consciousness that I have an invention which is to mark an era in human civilisation, and which is to contribute happiness to millions, would have sustained me through my trials in perfecting my invention. In order to save time on my instrument, I have lived in my studio, preparing my own food, which I carry from the grocery in small quantities in the evening. My apparatus must have the mechanical finish necessary for a public exhibition of it. I must not expose to ridicule what has cost me so many hours of laborious thought."

Porte Crayon, a student of the New York University, tells the following story:—"I engaged to become one of Morse's pupils in painting. He had three others. I soon found that the Professor had little patronage. I paid my fifty dollars, that settled one quarter's instruction. I remember when my second was due, my remittance from home did not come as expected, and one day the Professor came in and said courteously, 'Well, my boy, how are we off for money?' 'Why, Professor, I am sorry to say I have been disappointed, but I expect a remittance next week.' 'Next week!' he repeated, sadly, 'I shall be dead by that time!'

"'Dead, sir?'

"'Yes, dead by starvation.'

"I was distressed and astonished. I said hurriedly, 'Would ten dollars be of any service?'

"'Ten dollars would save my life, that is all it would do.'

"I paid the money, all that I had, and we dined together. It was a modest meal, but good. After we had finished, he said—

"'This is my first meal in twenty-four hours. Don't be an artist, it means beggary. A house-dog lives better. The very sensitiveness that stimulates an artist to work keeps him alive to suffering.'"

It was in those dark days that he wrote to his motherless daughter—"There are now indications of a change, and while I prepare for disappointment, and wish you to prepare for disappointment, we ought to acknowledge the kind hand of our heavenly Father. But it may be a long time before anything is realised. Study prudence and economy in all things."

England had refused to give Morse a patent, claiming that Wheatstone, an English inventor, had preceded him with his Magnetic Needle Telegraph (which would not record). English scientists, however, affirmed that the American invention was far ahead of Wheatstone's, and influential men assured Professor Morse that they would see that justice was done him. France had recognised the originality and merit of the invention, and Arago and Humboldt had conferred great honour upon the inventor before the French Institute. Distinguished scientists all over Europe declared that Professor Morse had solved the hard problem at last; that man might talk with his fellow-man in any part of the globe. But France, like England, refused to grant him a patent. The

press throughout Europe spoke of his invention with enthusiasm, and he received many encouraging letters. But his progress was blocked by his poverty.

"I am crushed for want of means," he wrote at this time, "and means of so trifling a character, too, that they who know how to ask (which I do not) could obtain in a few hours. One year more has gone for want of these means. I have now ascertained that, however unpromising were the times last session, if I could but have gone to Washington, I could have got some aid to enable me to ensure success at the next session. As it is, although everything is favourable, although I have no competition, and no opposition, yet I fear all will fail because I am too poor to risk the trifling expense which my journey and residence in Washington will occasion me. I will not run in debt if I lose the whole matter."

To recount all his discouragements before success came would make a long story. It was in the summer of 1842 that he insulated a wire two miles long, with hempen threads well saturated with pitch-tar, and surrounded with india-rubber. One moonlight night he laid this wire between Castle Garden and Governor's Island, he unreeling it while his single assistant rowed their little boat. He had succeeded in passing several signals through the "cable," when some sailors on a distant vessel drew up an anchor, bringing the wire with it, which they severed at once, carrying away a good part of it.

It was a defeated success. The experiment was repeated in the canal at Washington some time after without interruption. In describing the experiment to the Secretary of the Treasury in a letter dated December 23, 1844, Professor Morse was a true prophet of the Atlantic Submarine Cable. After speaking of the law deduced from the experiments, he said—"The practical experience from this law is, that a telegraphic communication on the electro-magnetic plan may with certainty be established across the Atlantic Ocean. Startling as this may now seem, I am confident the time will come when the project will be realised."

CHAPTER III.

THE GROWTH OF THE IDEA.

"Morse made no claims for anything," says Professor Henry, "but his particular machine and process for applying known principles to telegraphic purposes."

It was in the winter of 1843 that Professor Morse went to Washington to make a final effort to get a Bill before Congress, giving him an appropriation of thirty thousand dollars to be expended in testing his telegraph. He must build a line if he would show the world what his telegraph could do, and a line could not be built without money.

Now the committee before which he pleaded for the appropriation seriously considered him what we call a "crank" to-day, and a very tiresome crank. And here we first hear of Hiram Sibley in telegraphy.

"No, I did not go to Washington to help Morse get the appropriation." says Mr. Sibley. "That is the way the story is sometimes told, I know. I don't remember that I was particularly interested in telegraphs until a lady begged me to go to the Committee who were to present the Morse Bill, if it was presented at all, and do what I could to secure a favourable hearing for Professor Morse. And so I went. 'And you really think there is something in this man's invention, do you?' asked the Chairman of the Committee. 'Well, then, keep him away from the committee-room. Why, he undertook to prove to us that he could send ten words from Washington to Baltimore in two minutes and a half. Good heavens! If he had said twenty, we might have thought he knew what he was talking about.' I didn't wonder at their incredulity," says Mr. Sibley, "but I kept my doubts to myself, and defended the instrument. What was an appropriation of 30,000 dollars by a government like ours for testing an invention which scientific men had declared to be priceless to civilisation?"

The Bill was presented, and a merry time our Congressmen had over it. If thirty thousand dollars

might be given to a Magnetic Telegraph, then Millerism and Mesmerism and any ism should have a dive into the National Treasury. Of the twenty-four States that voted, five voted solidly against the Bill, New York State gave the greatest majority for it—twenty-two ayes against eleven nays. The Bill passed by the small majority of eighty-nine ayes to eighty-three nays, a *viva voce* vote, the members who had voted for it objecting to a proposed reconsideration, lest the record of their having sustained the Bill might jeopardise their position with their constituents. But getting the Bill through the Senate was a more difficult matter. The Senate would kill it emphatically, it was said, if he took it up at all. Day after day went by, and the inventor's board bill was fast eating up his scanty hoardings. Late one night, when the Senate was impatient to adjourn, the Bill finally came up. All alone in the gallery sat the man whose future depended upon that vote. A Senator, Hon. Fernando Wood, who knew him well, and knew the prevailing opinions of the Senators concerning Magnetic Telegraphs, went to him and kindly said—

"There is no use in your staying here. The Senate is not in sympathy with your project. Give it up, Morse. Go home—think no more about it."

And he went home straightway, or back to his boarding-house. He had given up. He would confront opposition and ridicule no longer. He would

submit to his fate. His heart was heavy, and perhaps he was not sorry to be utterly alone. Before going up to his room he paid his board bill, including breakfast for the following morning. That left him just thirty-seven cents, all the money he had in the world. He crept slowly up the long stairs, and shut the door of his little room behind him. It seems almost a sacrilege to tell how he knelt down beside the bed, and there gave up his hope of success, with the comforting thought that he had done his best to accomplish what he had believed was for the good of mankind. A sweet peace took possession of his soul, and he slept that night like a tired child.

He was eating his breakfast alone when a young lady came in, Miss Annie Ellsworth, the daughter of his friend, Hon. Henry L. Ellsworth, the First Commissioner of Patents. Her face was beaming with joy when she extended her hand—

"I have come to congratulate you, Professor Morse."

"Upon what?" he asked

"Upon the passage of your Bill by the Senate. Am I the first to tell you the good news?"

"You must be mistaken," he replied, his spirits slowly rising. "Its fate was sealed last night."

"But father sent me to tell you about it," she persisted. "He staid until the session was closed, and yours was the last Bill but one acted upon. It was passed just five minutes before the adjournment.

I am so glad I have the pleasure and the honour of bringing you the news."

Mr. Ellsworth's high personal and official position had done much in gaining the victory. Professor Morse made Miss Annie promise that she would send the first message over the wires when the telegraph was fairly in operation, and a little more than a year from that time, when the line between Washington and Baltimore was completed, she sent him the first message ever transmitted by a recording telegraph. Professor Morse was in the Chamber of the Supreme Court, Washington, and Miss Ellsworth in Baltimore when it came in triplicate, in the dot and line language—

"What hath God wrought?"

Among the treasures of the Connecticut Historical Society is that first telegraph despatch, dated May 24th, 1844.

Having gained his appropriation, Professor Morse lost no time in building his experimental line. The Government gave him a salary of 2,500 dollars per annum.*

The world was by no means convinced that Congress was not wasting a great deal of money on a

* Ezra Cornell, since famous as the founder of Cornell University, but then a poor man, was superintendent of the construction of that experimental line. The machine-shops of the cotton-mill where Ezra Cornell worked as a young man were on the very ground where Cornell University now stands. The magnificently endowed College of Mechanic Arts (Cornell) is named after Hiram Sibley, its benefactor.

delusion. One public man asked in all seriousness how large a bundle could be sent over the wires, and if the United States would risk sending mail bags that fashion. A wag threw a pair of boots over the wire outside the Washington office, and declared that they had just come from Baltimore. But the Democratic Convention which met at Baltimore soon after the line was in working order advertised the telegraph as nothing else could. The results of the ballots by which Polk was nominated, and Van Buren defeated, were sent to Washington. Silas Wright, who was in Washington, was nominated Vice-President, and notified of the same by telegraph. After receiving by telegraph four successive answers from Mr. Wright, declining the nomination, the Convention, which could not believe in the despatches, adjourned until the next day, when a committee was sent to Washington to get "reliable information on the subject."

It was something of a victory for Professor Morse when the committee reported that the telegraph was correct, and the Convention was convinced of its reliability.

This is a specimen of the comments the telegraph called out in the newspapers:—

> "What more, presumptuous mortals, will you dare?
>   See Franklin seize the clouds, their bolts to bury;
> The sun assigns his pencil to Daguerre,
>   And Morse the lightning makes his secretary."

CHAPTER IV.

PIONEER TELEGRAPHY.

AFTER all, the telegraph line did not pay expenses. The receipts of the first four days were just one cent, an experimenter saying "No" by cipher (0) to a test question. At the end of the first month they were $1.04. Among the decided oppositionists to the new order of things was an Irishwoman living in a shanty beside a telegraph pole. "Shure, now, I can never wollops the childers but they hears me all over creation."

What a bargain it would have been for Uncle Sam, had he taken Professor Morse's invention off his hands, as Professor Morse hoped he would do when he offered it out and out to the Government for one hundred thousand dollars! Think of the annual profits of the Western Union alone—its net earnings exceeding seven millions a year. But Uncle Sam thought one hundred thousand dollars a ridiculously large sum to invest in what Mr. Cave Johnson, the Postmaster-General, declared could never become a paying concern, and such it never might have been but for the confederation of the Western Union. It was one of the bitterest disappointments of Professor Morse's life, however, when the

Government refused his offer, and declined to invest in his invention. He began at once to sell the right to build lines to private capitalists. Large capitalists were unwilling to take hold. Rochester, N.Y., be it remembered, was first of all the cities of the United States to furnish men and money for a telegraph line. Leading citizens organised a company, through which Henry O'Reilly (identified with the public movements not only of Rochester, but of the State) contracted for a line to he extended over a wide and valuable territory. The "O'Reilly Lines" are identified with pioneer telegraphy. New York capitalists refused decidedly to invest in telegraphy, as did those of all the seaboard cities; and it was not the capitalists of Rochester, but its leading business and professional men, who furnished the means for the O'Reilly lines

Most interesting are the stories of pioneer telegraph building. When building the line between Philadelphia and Baltimore no directions were given about insulation, in fact no one seemed to know much about insulation. The order was to cover the wires with tar, and a green Scotsman went forth, tar-bucket and sponge in hand, to tar the wire. "He tarred it as far as Wilmington," says Reid; "there tar proved too much for him. He went to sleep, and never woke. We buried him there. When he was gone no one would take his place. I took the bucket and sponge and lathered the electric road to the Susquehanna. There O'Reilly made a bonfire of my saturated

garments. All the tavern keepers on that road remember the man with the tar-bucket. At the town of North-East they would not give me a bed."

Again, "in building a line between Harrisburg and Lancaster, 'the boys' were directed to dip cotton cloth in beeswax as a method of securing good insulation. David Brooks, a relative of O'Reilly's, was delegated to purchase a supply of beeswax, and to contract for cotton cloth. The rags were cut by Henry Hepburne, a Rochester boy, afterwards a Wall Street broker, who didn't take to the business much, and who made sport of the wax-pot. The room, with the waxed rags lying round to dry, looked much like a hospital in preparation for a wounded host. Wrapping the waxed cloths around the grooved pins, the wires were embedded in the grooves, and strung tight from pole to pole. The line looked very trim and handsome. We noticed that some enterprising bees came to our waxed rags, but their opportunity for replevin was brief, for a heavy rain and a sharp frost soon left our cotton insulation fluttering in the air, and bees, wax, and cotton disappeared."

In a few years ridiculing the telegraph was a thing of the past. It was recognised as the greatest discovery of the age, its inventor, the benefactor of mankind. Honours were heaped on him, and costly gifts from the sovereigns of leading nations poured into his magnificent collection of testimonials. The Sultan of Turkey gave him the decoration of the

Order of Glory; the King of Prussia sent him a massive gold snuff-box, sparkling with jewels; from the Emperor of the French came the Cross of the Legion of Honour; from the King of Denmark, the Cross of Knight Commander; from the Queen of Spain, the Cross of the Order of Isabella the Catholic. The ten Powers of Europe held a special congress, and gave four hundred thousand francs (80,000 dols.) as an expression of the gratitude of their subjects to the inventor of the magnetic telegraph. Banquets became common affairs to the man who had known hunger and loneliness in his devotion to an idea.

CHAPTER V.

EVOLUTIONS OF THE IDEA—THE WESTERN UNION —THE PACIFIC TELEGRAPH—THE RUSSIAN OVERLAND—THE ATLANTIC CABLE.

THERE have been four eras in the history of the Magnetic Telegraph. In each of those eras a citizen of the United States has been conspicuous.

The first era was that of the study of the phenomena. Here we find Benjamin Franklin, whose story is told in another volume of the "World's Workers" Series. Franklin was the first to demonstrate that lightning and electricity are identical. The success

of his experiments in drawing lightning from the clouds with a kite gave a wonderful impulse to the study. "The electrical spark," he wrote in 1794, "is zigzag, and not straight, so is lightning. Pointed bodies attract electricity; lightning strikes mountains, trees, spires, masts, chimneys. Electricity chooses the best conductor, so does lightning. Lightning reverses the poles of a magnet, so does electricity. Lightning destroys animal life, so does electricity when sufficiently powerful."

His kite experiment was made in 1752, and it was a heroic demonstration of his theory. He was fully aware that he was not only risking his life, but facing the ridicule of the world, should the experiment prove a failure. "The result," says Park Benjamin, in his "Age of Electricity," "would brand him as a madman and a suicide, or raise him to the topmost pinnacle of human fame." An account of the famous experiment may be read in any of the many Lives of Benjamin Franklin. We are all familiar with the picture of the kite flying in the thunder-storm, which helped to prove that lightning and electricity are identical.

The kite experiment was followed by a profusion of similar ones in all parts of Europe. Franklin's lightning rod, the first ever known, made his house in Philadelphia something to be stared at. When he added a chime of bells, which gave notice of atmospheric changes, he was regarded with no little distrust by the ignorant and superstitious, who agreed with the

Abbe Nollet that it was as impious to ward off heaven's lightning as for a child to ward off the chastening rod of its father.

As early as 1748 he had sent an electric spark across the Schuylkill River—a prophecy of the Atlantic Submarine Cable of 1866.

The second era was that of invention—the era of Morse, Henry House, and Daniell. Had the Daniell Battery been known in 1827, one Harrison Gray Dyer, of New York, would have given to the world what Professor Morse did not complete until some seventeen years after.

The third era was that of the evolutions of the telegraph—the multiplication of its effects. Of the many names conspicuous in this era, none are more deserving of special mention than Hiram Sibley, and none take precedence of Thomas Alva Edison.

The pioneers of telegraphy, men like Henry O'Reilly, Ezra Cornell, Amos Kendall, and Cyrus W. Field, men who built the first lines, overcoming difficulties they had possibly held back from facing could they have measured them in advance, have each a historic record inseparable from their age. They belong to the era of administration, the fourth era in the history of telegraphy, an era of chaos in its beginning, when Morse lines, Bain lines, House lines, and O'Reilly lines, with their endless litigations over infringements of patents and broken contracts, local jealousies, disastrous competitions, unequal and

capricious tariffs, made investing in telegraph stock a sure method of throwing away money. Prior to 1855, ten years after the success of the experimental line between Washington and Baltimore, out of the thirty or forty telegraph companies only two or three were paying expenses. The crisis of telegraphy had come, and it was a financial failure, unless the rabble of conflicting interests could be organised into one federation. Morse had planted the vine that was running wild in riotous strength. Hiram Sibley and his Western Union so pruned and trained that vine that the story of its fabulous vintage soon surpassed the evolution of Aladdin's lamp. The Western Union was the salvation of telegraphy, and the idea of the Western Union was Hiram Sibley's. He was the sole projector until the scheme won the confidence of stockholders. Hiram Sibley, it will be remembered, had something to do with the securing of the appropriation for Professor Morse, whereby he was enabled to build an experimental line in 1844. Mr. Sibley little thought, when he gave a helping hand to the neglected infancy of the Magnetic Telegraph, that it would be his to save its vigorous youth from failure and disaster.

"I have made a study of the financial successes of the world," A. T. Stewart used to say, "but I never could find anything to compare with the Western Union."

When Hiram Sibley first confided his scheme to

business men of Rochester, N.Y., they laughed at the idea of consolidating the many telegraph lines of the country into a harmonious union. "Sibley's Crazy Scheme," it was called, even by men who reluctantly invested in its furtherance, and who lived to see their expectation of loss give way to amazement at fabulous gain.

It did seem like a crazy scheme, the buying up of broken-down telegraph companies, assuming their liabilities, accumulating their worthless stocks, &c. The original company of seventeen stockholders, subsequently increased to twenty, was organised in Rochester, N.Y., and was composed almost entirely of Rochester men. The five thousand dollars each invested, the most of them doing so simply because Hiram Sibley talked them over against their will, was the nucleus of a fortune. It was no secret that Hiram Sibley had mortgaged everything he owned, and had borrowed heavily in his determination to carry out his project. He was called "a line gobbler" in those days, when he was said to go up and down the land, grip-sack in hand, buying up telegraph stock at nominal prices. Ridicule mattered little to him if the necessary capital for buying up telegraph companies and the controlling interests of patents could be obtained. Within forty-three days subsequent to the organisation of the Western Union Telegraph Company Sibley had acquired the majority of stock necessary for operations.

As trustee of the New York and Mississippi Valley Printing Telegraph Company (House Patent), a consolidation of that Company had been effected with the Erie and Michigan (Morse Patent) in 1856, under the title of Western Union. The idea of the Western Union was the *federation of the telegraphic interests of the country.* The pluck and enterprise of telegraphy must be made secondary to a strong controlling government—the genius of monopoly, in short—or prove a mechanical as well as a financial failure. The depression in telegraph stocks made acquisition of them an easy matter, comparatively, to one acquainted with the pecuniary embarrassments of the companies. Mr. Sibley gave his time for more than three years to buying up the stock of the worthless corporations, some of it as low as two cents on the dollar. In this way he consolidated the lines of thirteen States.

"I cannot see how this consolidation of failures is to escape failure," says one who would not be so rash as to invest five thousand dollars in "Sibley's crazy scheme." "There can be nothing in the result which is not in the cause, and where do we find the element of success in telegraphs? This Western Union seems to me very like collecting all the paupers in the State and arranging them into a union, so as to make rich men of them." Said another, whose opinion had great weight at that first meeting of the seventeen Rochester men who were to answer Mr. Sibley

finally as to whether they would each subscribe five thousand dollars or not: "Admitting all that Mr. Sibley says about the security of our investment, it is not at all probable that any one of us here present will live to see the success of the scheme."

"The ninety thousand dollars subscribed at that meeting," says Mr. Sibley, "was all the money that was ever paid. The balance was money loaned on bonds of the Company, and individual loans. Isaac Butts promised the other ten, and paid it in stock of other lines. That one hundred thousand dollars, with what was gained by the consolidation of the House lines outside the State of New York, constituted the property of the Western Union Telegraph Company in 1856, and soon exceeded in value the whole assessed value of the property real and personal of the City of Rochester. As fast as we could make a line pay seven per cent. we put it in. The increase was in making worthless property valuable. The original stockholders, who did not get frightened and withdraw their investments, had no chance to escape being millionaires."

Fifty thousand dollars in Western Union in 1857 meant two millions in 1865. The capital of one perishing telegraph company, valued at 240,000 dollars, was easily bought by Mr. Sibley at two cents on a dollar. The price paid for the extensive O'Reilly lines was the cost of running them for one year. Once absorbed into the Western Union the weakest

line was infused with new life and vigour. In 1865 the head-quarters of the Company were removed from Rochester to New York. December 23, 1863, Western Union Stock rose to 225, and the holder of the most infinitesimal share believed himself a second Aladdin. Everything that could be invested in Western Union was invested at any cost. "While the public mind was thus excited," says the author of "The Telegraph in America," "the Board declared a dividend of one hundred per cent., increasing the capital to 21,066,400 dollars. It was clear and unmixed water. This dividend, after a few years, seriously endangered the stability of the Company, and rendered its administration obnoxious and perilous. The added millions became a millstone, the full weight and drag of which was not felt for years. It was felt when leading telegraph companies came to form with the Western Union a great compacted company. To settle the representation of capital on a just basis, many millions of stock in excess of what would have been necessary had that hundred per cent. dividend not been declared, had to be issued. The water in the capital of one company had to be equalled with water in all the rest. Instead of an easily-handled capital of at most 25,000,000 dollars, a swiftly-coming era of shrinkage and broken values had to be confronted with one of 41,000,000 dollars.

But the Company was strong enough to bear the strain as well as the loss of 3,000,000 dollars in the

Russian extension (1866). The value of its property was increased by twenty millions of dollars within the next ten years. In 1883 the capital of the Western Union was 80,000,000 dollars. It commanded four-fifths of all the telegraph business of the country, and its wires would girdle the earth seventeen times. Its net earnings had increased threefold, although the receipts for messages had been reduced more than one-third. It had contracts with more than 600 railroad companies, while its patents were innumerable. It still has vigorous rivals; but the strength of the great monopoly in controlling rates makes the prosperity of rivals uncertain. It absorbs the inventions of scientific mechanicians for improving the instruments. Edison's quadruplex system of telegraphy added to the lines of the Western Union at the time of its adoption the equivalent of fifty thousand miles.

Hiram Sibley was the first President of the Western Union, and held the office for sixteen years. Under his management the number of telegraph offices was increased from 132 to over 4,000, and the value of the property from 220,000 dollars to 48,000,000 dollars.

THE PACIFIC TELEGRAPH.

As every electrical invention has more than one claimant for the honour of having conceived its essential idea, so the Pacific Telegraph, one of the earliest and most important evolutions of telegraphy, has

many claimants for fatherhood. It was in the order of things that such a project should be thought of, at least in California. In 1857, before the first stage had crossed the plains, Henry O'Reilly contemplated undertaking building a line to the Pacific coast. Planning such an enterprise, and carrying it out, were two different things.

In 1857 we find Hiram Sibley urging the Western Union to undertake a California line. "Who but Sibley would dream of such a thing?" it was said. "The Indians will cut down the poles, even if poles can be furnished without ruinous cost. Think of stretching a wire over the Rockies and across the plains! It will never pay while there is so much uninhabited country this side of San Francisco. Better wait until a railroad is built."

The Western Union would have nothing to do with the project at the outset, nor would that other strong organisation, the North American Telegraph Association. More than that, not a member of either company would risk a single dollar in the new project.

"Very well, gentlemen," said Mr. Sibley; "if you won't join hands with me, *I'll go it alone.*"

He went to Washington, secured a hearing, and the passage of a Bill June 16th, 1860, "to facilitate communication between the Atlantic and Pacific States by electric telegraph." The articles of agreement between Salmon P. Chase, secretary of the Treasury, and Hiram Sibley, signed November, 1861,

are a notable document. Mr. Sibley individually and alone contracted for the building of the whole line, to be completed within two years, the Government to have preference in the use of the same, and to pay a subsidy of 40,000 dollars for ten years. Should the business transmitted for the Government at ordinary rates exceed the amount of the subsidy, the excess was to be submitted to Congress, the contract containing no provision for the payment of any additional sum by the Department.

Mr. Sibley at once sublet the building of the section between San Francisco and Salt Lake to the California State Telegraph Company. After the completion of the whole line, the Western Union assumed the project, and organised the Pacific Telegraph Company, which was composed largely of Rochester men. The Pacific Telegraph Company was to operate the California line, and the lines acquired on the Pacific coast, through contract of Mr. Sibley with the California State Telegraph Company. The six bondsmen on Mr. Sibley's proposal to build the line were all Rochester men. Of the eight bondsmen on the contract after the completion of the line, six were Rochester men.

The contract held Mr. Sibley to complete the line in two years. *The work was done in four months and eleven days.*

The Pacific Telegraph was the most profitable line ever known, and the Western Union was immensely

enriched by it. It was considered by many a providential preparation for the war of the rebellion. When we think of the country it crossed, *ten years in advance of the railroad*, the extent of the undertaking may be better realised.

The Indians did not cut down the poles as had been prophesied, but their friendship with Mr. Sibley made them the protectors of the line. Gifts were freely exchanged between the parties, and years after the line was in operation the Indians were sending game and skins to Mr. Sibley, in token of their friendship. A black-tailed buck, the gift of White Cloud, died not long ago in his Rochester home.

The expense of the Government business largely exceeded the subsidy of 40,000 dollars a year. When the contract expired the United States Government was the debtor of the Western Union to the amount of 91,000 dollars. This sum was relinquished and made a gift to the nation, something to be remembered of the Great Telegraph Monopoly.

THE RUSSIAN OVERLAND.

The Western Union had been the salvation of telegraphy; and yet, until the telegraphic systems of the Old and the New World could be connected, there was a growing dissatisfaction with the invention. A telegraph that could not speak with Europe was in a sense a failure. Three notable failures prior to 1864, to span the Atlantic with a submarine cable, had

consigned long sea-cables in the minds of the people at least to the catalogue of impracticable theories. The Western Union would have nothing to do with Atlantic cables. It had lent an ear, however, to the project of Perry MacDonough Collins for building a telegraph line between Russia and America by way of Alaska and the Aleutian Isles. Collins had been over the ground, and obtained Russian and British grants, before submitting his scheme to Mr. Sibley for the co-operation of the Western Union. We find Sibley writing to Collins, October 16th, 1861, before the new enterprise had been officially undertaken by the Western Union :—" If the Russian Government will meet us at Behring Straits, and give us the right of way through the territory of the Pacific, we will complete the line in two years, probably in one. The whole thing is entirely practicable. No work was ever accomplished by man that will be so important in its results. The benefit to the world will pay its entire cost every year after its completion."

The junction of the Western Union and Russian lines was to be at the mouth of the Amoor, the Siberian port of the North Pacific. The connecting link between British Columbia and the Amoor would be about 2,800 miles long. It would cost, it was thought, about 300 dollars a mile. Even the submarine cable, of some forty miles across Behring Straits, was not considered a serious obstacle by the enthusiasts of the project. There were no difficulties

in the whole undertaking, it was said, so hard to master, as those the Pacific Telegraph had mastered completely. The cost would not exceed five millions of dollars. What were five millions compared with the gain to civilisation and science? And then there were unpleasant complications between the United States and England, growing out of the War of the Rebellion, the depredations of the *Alabama*, &c., making a telegraph to our good friend Russia the most desirable thing in the world for mutual interests. Most eloquent was the advocacy of the project in Congress, and Secretary Seward, when Secretary of State, endorsed it with enthusiasm. The contract between Collins and the Western Union was signed in Rochester, N.Y., March 24th, 1864. The Western Union at once bought up all the stock it did not own of the Pacific Telegraph Company, and so had undivided control of telegraphic interests from the Atlantic to the Pacific.

"Russian stock" was "booming," and in demand from thirty to sixty cents above par. The Atlantic Cable Company was under a cloud, but still persisting in carrying out its idea. Its stockholders were considered fortunate, however, if they could rid themselves of their investment below par.

The expedition for exploring the route of the proposed Russian overland set sail from San Francisco in the summer of 1865. A considerable fleet, divided into parties of construction, engineer corps, and

scientific corps, each under a chief, and military discipline. There were some thirty vessels in all, and about 120 men. Thousands of tons of wire, two cables, telegraphic instruments, &c., were duly shipped for the head-quarters of the four divisions of the expedition: British Columbia, the Yukon, Siberia, and the Anadyr.*

The first craft of a white man to ascend the mighty Yukon River was the little steamer, *Anson Stager*, belonging to the telegraph expedition. The standard map of the Yukon was drawn largely from surveys made by the scientific corps of the expedition. They discovered rivers and named them, and were the first white men to pass over many a long mile of wilderness explorers of to-day claim to have first explored. The heroism of the expedition, the devotion of the men to their duty, their extreme suffering in building telegraph across Arctic wastes, their awful experiences with famine, loneliness, and perilous journeys, has not the place in history such an expedition would have had but for the success of the Atlantic cable, which gave the death-blow to the Russian Overland, August, 1866. Had "the Russian" won the prize of the two gigantic enterprises, every

* The explorations of these several parties in the three years they gave to the Russian overland telegraph may be read in the books written by members of the expedition: "Alaska and its Resources," by Wm. H. Dall; "Reindeers, Dogs, and Snow-shoes," by Richard J. Bush; "Tent Life in Siberia," by George Kennan; "Travels in Alaska, and the Yukon," by Frederick Whymper.

incident of the exploring expedition, no doubt, had had as many versions as that of the battle of Gettysburg. Some of the men worked on at their lonely outposts for more than a year after the cable had made their work in vain. The piles of telegraph poles they collected in Siberia were left for the camp-fires of the wandering Koraks, while the boys at Norton Sound, when they were recalled, hung the poles they had planted in the deep-frozen ground with all the black cloth they could spare, and turned their backs on the weird monuments of a defeated success.

"It seemed hard," wrote Kennan of the Siberian party, "to give up the object for which we had devoted three years of our lives, and for whose attainment we had suffered all possible hardships. . . We had prepared about 15,000 poles, built between forty and fifty station-houses and magazines, and cut nearly fifty miles of road through the forests. . . Besides seventy-five Americans, we had a force of one hundred and fifty natives at work; . . . and six hundred more were on their way. . . Our facilities for transportation another year would have been unlimited. We had a small steamer on the Anadyr River, and had ordered another for Penzhina. We owned one hundred and fifty dogs, and several hundred reindeer. By the 1st of September we would have been able to take the field with nearly 1,000 men."

It was impossible for an overland telegraph to compete with a successful submarine cable across the

Atlantic, and the project was given up by the Western Union without delay.

"It is a proof of the strength of the Western Union Company at that period," writes Reid in his "Telegraph in America," "that it footed the bill of the Russian Expedition without a shiver, and without at all reducing the market value of its stock."

The Western Union offered bonds for the redemption of the extension stock, issuing 3,170,292 dollars of bonds for that purpose. The project was soon forgotten in the universal joy attending the success of the Atlantic cable. It would be interesting to know if the wild Chookchees of Siberia had not interwoven it in their myths, explaining to their children why the pale faces came among them, and collected piles of wood for their camp fires.

THE ATLANTIC CABLE.

When Dr. Montgomerie, a surveyor of the East India Company, made a scientific study of the whips he saw used in Singapore in 1822, and discovered the great utility of the material they were made of—gutta-percha—introducing the same to the commercial world in 1842, he was making a most important contribution to submarine telegraphy, then unknown. Gutta-percha and telegraphy are inseparable. It is the cheap, lasting, and powerful insulator, without which we might be lacking an ocean telegraph to-day. Dr. Montgomerie sought for something in

the Singapore whips for the improvement of splints and surgical apparatus. He little thought he was mastering a gigantic obstacle to the world's civilisation, that he was making that civilisation dependent for its sinews upon a few islands in the Malayan Archipelago.

Millions of dollars had been sunk in unsuccessful Atlantic cables, and thousands of miles of electric wire had been consigned to the fishes before August 26th, 1866, when the Atlantic Cable was proved a success.

The first practical submarine telegraph cable had been laid by Professor Morse in New York harbour October, 1842. Gutta-percha was first used as an insulating covering on a short line laid not long after, across the Rhine between Deutz and Cologne. The first great venture was in 1850, a sea-line between Dover and Calais. Great Britain and Ireland were connected by cable in 1852, and Scotland and Ireland as well. Then England and Holland, a distance of 115 miles.

A Roman Catholic bishop in St. John's, Newfoundland, Bishop Muloch, wrote an article for one of the provincial papers under date November 8th, 1850, which proved an important step in the development of submarine telegraphy. He urged making St. John's, Newfoundland, a point where the telegraph system of the United States and Canada should focalise. European news should be sent from St.

John's by special steamers, or carrier pigeons, or by cable. There were four hundred miles of dense wilderness between St. John's and Cape Ray, and a cable between Cape Ray and Cape Breton would be a great undertaking. The project was carried out, however, in 1852, the first cable of any considerable length in America, but it gave out in 1853, and then the soul of the enterprise, Mr. Gisborne, went to New York for help, and among the gentlemen he met, with a view of interesting them in his project, was Cyrus W. Field, a name for ever associated with the Atlantic Cable. "Standing one evening over a large globe," says Reid, "and tracing the lines overland to St. John's, Newfoundland, an idea dawned in his mind, which soon absorbed his whole heart and life. Following with his finger the track of the inland lines to the ocean—the course of the steamers over 1,611 miles, separating two continents from each other—it was but a step farther to plant the finger on London, and feel that to reach the centre of English civilisation by telegraph from America would be the sublimest work of the age." Mr. Field's study of the subject strengthened his faith that the thing could be done. A recent Government survey of the bottom of the ocean showed him a plateau or table-land between Newfoundland and Ireland, an under-ocean pathway waiting the hour when science should demand its use. Professor Morse encouraged his hopes. He had always believed in an Atlantic telegraph.

An Atlantic Telegraph Company was organised in 1854, with a capital of 1,500,000 dollars; Peter Cooper, President; Chandler White, Vice-President; Moses Taylor, Treasurer; and Professor Morse, Electrician; Matthew D. Field, Engineer. Cyrus W. Field was the inspiration and the motive power of the enterprise, and but for his zeal and indefatigable perseverence under the succession of disastrous failures it encountered between 1857 and 1866, it may be questioned if the Atlantic Cable had yet been a success. When the public lost faith, and even some of the officers of the Company turned their back upon any renewal of the effort, Field worked on assiduously, crossing the ocean some fifty times in his devotion to his unlucky cables.

The cable of 1857 was 2,500 miles long, and so flexible it could be tied around the arm without injury. It was covered with gutta-percha, the gutta-percha covered with tarred yarn, the whole passed through a bath of melted pitch. About 180 miles had been submerged, the vessels starting out with it from Valentia Bay, Ireland, when, owing to a mistake of the engineer, the cable snapped while being laid at a depth of two miles, and when everything seemed going well.

Professor Morse held that this first cable was essentially defective. "What has been gained by this loss?" he wrote. "An amount of experience and knowledge for which the loss of three hundred miles

of cable is a cheap purchase. Better lose three hundred miles than the whole cable."

The second cable sailed from Plymouth, England, for mid-ocean in two sections, May, 1858. Half of the precious freight was on board the *Niagara*, of the United States, the other half in the *Agamemnon*, of the British Navy. Ships and cables suffered from the terrible storms encountered, but finally the cable was spliced in mid-ocean, and the *Niagara* was sailing away for Newfoundland with one end of the treasure, and the *Agamemnon* for Ireland with the other, and some two hundred miles were between them, when snap went the cable at the stern of the *Agamemnon*, and the fleet returned to Queenstown, having contributed several hundred miles of cable to the vasty deep, in addition to the first deposit and loss.

The third cable went forth from the Cove of Cork, July, 1858, in the comrade ships, the *Niagara* and the *Agamemnon*. In mid-ocean the splice was effected, with a bent sixpence added for luck. Signals were constantly passed between the two ships, and on the same day, August 4th, 1858, the *Niagara* entered Trinity Bay, and the *Agamemnon* reached Valentia. The Atlantic Cable had finally been laid, and messages were passing through it. The first message was, "England and America are united by telegraph. Glory to God in the highest, and on earth peace and goodwill towards men." Queen Victoria sent a message to the President—what matter if it took

sixteen minutes for twenty words?—and the country was wild with enthusiasm. Never were such fireworks displayed in the great cities, the name of Cyrus W. Field emblazoned with the most skilful devices of the pyrotechnist, while the press was overladen with the tributes of poets, of course, and the preacher that did not give a special sermon upon the engrossing subject was out of harmony with his time. Two weeks of enthusiasm, and then—what was the matter? There was an electrician at Trinity Bay named De Sauty. He was overwhelmed with despatches, asking what was the matter; to all of which he replied: "All right. De Sauty." After a time De Sauty stopped replying, and the fact was slowly accepted that the Atlantic Cable was a failure—it was dead. Dr. Holmes wrote an amusing "Electro-Chemical Eclogue" about De Sauty, a supposed conversation between a Professor of Chemistry and a "Blue Nose":—

> "Tell me, O Provincial! speak, Ceruleo Nasal!
> Lives there one De Sauty extant now among you,
> Whispering Boanerges, son of Silent Thunder,
> Holding talk with nations?"

The Blue Nose answers—

> "Born of steam galvanic, with it he hath perished,
> There is no De Sauty, now there is no current!
> Give us a new cable, then again we'll hear him
> Cry 'All right. De Sauty.'"

The rumour gained credence that there had been no messages by the cable at all—that it had never

operated—that the public had been deceived. But that was untrue. It had worked imperfectly and irregularly for twenty days. It had told us of a British treaty with China, allowing the Christian religion, and it had saved Great Britain £250,000 sterling, by preventing the return to England of two Canadian regiments it was Her Majesty's will to keep where they were. Gradually it came out that the cable had been a defective one, that the failure was owing to the imperfect mode in which it had been manufactured, and carelessness in its storage. The gutta-percha was broken in places, and the insulation destroyed. Unfortunately for the little faith left in long submarine cables, the Red Sea telegraph cable "died suddenly in its bed" at this jointure, and Great Britain was out of pocket in that venture to the tune of one million pounds sterling. What wonder that the few believers in an Atlantic cable winced a little at the jibe, "All right. De Sauty?" Three stupendous efforts, and a lost cable, and to all appearances "the enterprise for eight years was dead as the host of Pharaoh in the Red Sea," excepting always signs of activity on the part of Cyrus W. Field. The American public was absorbed in the War of the Rebellion, and ashamed of its past enthusiasm over an Atlantic cable. It was no easy matter raising money enough for a new venture—a new cable; but Mr. Field finally succeeded in securing the capital, the British Government promising to pay 8 per cent.

on £600,000 of new capital for twenty-five years if a cable was successfully laid and made to operate in that time. Capitalists in England were enlisted, a union effected with the great Gutta Percha Company, and at last it was reported that a new cable was being manufactured, and that the *Great Eastern* had been purchased for laying it from shore to shore. Every improvement in submarine telegraphy was made to contribute to the success of the new cable, and in July, 1865, one end of the gigantic coil in the capacious hold of the *Great Eastern* was made fast to the shore at Valentia Bay, and the ship sailed for Newfoundland. Six hundred miles from Newfoundland the cable parted—was broken—gone—and twelve hundred miles of the earth's electric girdle was afloat in the bottom of the sea. Fishing for it at a depth of two miles detained the *Great Eastern* in the locality of its loss for several days. Three times it was caught and partially raised, but the ropes could not bear the strain. "We had four ships," as Cyrus W. Field tells the story, "and on board of them some of the best seamen in England—men who knew the ocean as the hunter knows every trail in the forest. There was Captain Moriarty, who was in the *Agamemnon* in 1857-58. He saw the cable when it broke; and he and Captain Anderson took their observations so exact that they could go right to the spot." A vigilant watch was kept on the end of the line in the office, where the broken cable gave strange incoherent

messages upon the graduated scale before its mirror. "Night and day," an English journal tells us, "for a whole year, an electrician was always on duty, watching the tiny ray of light through which the signals are given,* and twice every day the whole length of wire—1,240 miles—was tested for conduction and insulation. The object of observing the ray of light was, of course, not any expectation of a message, but simply to keep an accurate record of the condition of the wire. Sometimes, indeed, wild, incoherent messages from the deep did come; but these were merely the results of the magnetic storms and earth currents, which deflected the galvanometer rapidly, and spelt the most extraordinary words, and sometimes even sentences of nonsense, upon the graduated scale before the mirror."

It was following the failure of 1865 that the Russian Overland Telegraph was projected. The world had had enough of Atlantic submarines, and Cyrus W. Field was considered a lunatic by many when it was known that he had formed a new company for his disastrous enterprise, and that a new cable was being made.

Once more the *Great Eastern* was freighted with over two thousand miles of cable, and Friday, July 13th, 1866, after an impressive religious service, it sailed for the Bay of Newfoundland. On

* The peculiar methods of submarine telegraphy cannot be explained here.

Friday, July 26th, 1866, the cable was safely landed on the American shore.

The recovering of the lost cable of the year before is best told in Mr. Field's own words in Benjamin's "Age of Electricity" :—

"Many don't understand it, and every day I am asked how it was done. It does seem rather difficult to fish for a jewel at the bottom of the ocean two-and-a-half miles deep. But it is not so very difficult when you know how. It was the triumph of the highest nautical and engineering skill. Having taken our bearings (from the buoys before mentioned), we stood off three or four miles, so as to come broadside on, and then casting over the grapnel, drifted slowly down upon it, dragging the bottom of the ocean as we went. At first it was a little awkward to fish in such deep water, but our men got used to it, and soon could cast a grapnel as straight as an old whaler throws a harpoon. Our fishing-line was of formidable size. It was made of rope, twisted with wires of steel, so as to bear a strain of thirty tons. It took about two hours for the grapnel to reach the bottom, but we could tell when it struck. I often went to the bow and sat on the rope, and could feel by the quiver that the grapnel was dragging on the bottom two miles under us. But it was very slow business. We had storms and calms, and fogs and squalls. Still we worked on day after day. Once, on the 17th of August, we got the cable up, and had it in full sight

for five minutes—a long, slimy monster, fresh from the ooze of the ocean's bed; but our men began to cheer so wildly that it seemed to be frightened, and suddenly broke away, and went down into the sea. This accident kept us at work two weeks longer; but finally, on the last night of August, we caught it. We had cast the grapnel thirty times. It was a little before midnight on Friday that we hooked the cable, and it was a little after midnight Sunday morning when we got it on board. What was the anxiety of those twenty-six hours? The strain on every man's life was like the strain on the cable itself.

"When finally it appeared it was midnight; the lights of the ship and in the boats around our bows as they flashed in the faces of the men, showed them eagerly watching for the cable to appear in the water. At length it was brought to the surface. All who were allowed to approach crowded to see it. Yet not a word was spoken; only the voices of the officers in command were heard giving orders. All felt as if life and death hung on the issue. It was only when it was brought over the bow and on the deck that men dared to breathe. Even then they hardly believed their eyes. Some crept towards it to feel of it, to be sure it was there. Then we carried it along to the electricians' room to see if our long-sought-for treasure was alive or dead. A few moments of suspense, and a flash told of the lightning current set free.

"Then did the feeling, long pent up, burst forth. Some turned away their heads and wept. Others broke into cheers, and the cry ran from man to man, and was heard down in the engine-rooms, deck below deck, and from the boats on the water, and the other ships, while rockets lighted up the darkness of the sea.

"Then with thankful hearts we turned our faces again to the west. But soon the wind rose, and for thirty-six hours we were exposed to all the dangers of a storm on the Atlantic. Yet in the very height and fury of that gale, as I sat in the electricians' room, a flash of light, a message, came up from the deep, which having crossed to Ireland, came back to me in mid-ocean, telling that those so dear to me, whom I had left on the banks of the Hudson, were well, and following us with their wishes and prayers. This was like a whisper of God from the sea, bidding me keep heart and hope. The *Great Eastern* bore herself bravely through the storm, as if she knew that the vital cord which was to join two hemispheres hung at her stern; and so on Saturday, the 7th of September, we brought our second cable safely to shore."

Five efforts and three cables and an expenditure of millions of dollars, and the work was done, and from that day to this the Atlantic Submarine has been a success. There are now five cable lines crossing the northern Atlantic. The longest stretch

of telegraphy is that between London and Calcutta, seven thousand miles, but you can chat over the line at the rate of fourteen words a minute. And yet the science of electricity is in its infancy.

"New applications of the telegraph are constantly being invented," says Park Benjamin. "We are only at the very beginning of its utilisation in the affairs of every-day life, and yet its developed capabilities are bewildering. There is little exaggeration in the statement that one can sit at home and steer a torpedo-boat in New York Harbour, or ring the bells in Boston, or play the organ in St. Peter's, or explode a mine in China, or write a letter on the desk of a correspondent in Constantinople, and perhaps in the future talk to a friend in Australia, and even see him face to face."

If Edison's inventions are to the inventions of the future no more than what Franklin's kite and lightning rod were to the Morse recording telegraph in its infancy, who can fortell the inventions of the next fifty years, the development of the science of electricity?

Franklin has been called the genius of the practical. Edison might be called the genius of the seemingly impossible. Morse stands between the two, the genius of demonstrated law and discovery.

We can easily believe that Franklin may have foreseen that electricity would be made to write, but who can believe that at the time he is said to have

wished he could see what the discoveries of his day would bring to pass in a hundred years or more, he dreamed that in 1887 we would be measuring the heat of the stars by the science of electricity, and hearing the sound of the fall of a sunbeam?

CHAPTER VI.

THE LAST MESSAGE.

PROFESSOR MORSE spent his declining years in his charming home, Locust Grove, on the Hudson. His winter home was at 5, West 22nd Street, New York, where he had a fine library.

"The Professor's private life," writes Benson F. Lossing, "was one of almost unalloyed happiness. His presence was always sunshine to his family, and his influence in society was benign. He was, in the highest sense of the term, a Christian gentleman, a faithful disciple of the Redeemer, and a fine exemplar of dutiful obedience to every law in all the relations of life, domestic and social."

Through his library windows at Locust Grove ran the telegraph wires which placed him in communication with all the world. Somebody has written of him that he sat there at times like a great spider in a wire web, reaching around the globe.

In the summer of 1871 a statue was erected to his memory in Central Park, New York, by the "telegraphic brotherhood of the world." Every State in the Union sent delegates, and the British Provinces as well. At the public reception at the Academy of Music in the evening the services were most impressive. The house was packed to overflowing. When the venerable man came upon the platform, the audience arose and cheered with unbounded enthusiasm. Who can doubt his remembering at that very moment the lonely little room at the corner of Beekman and Nassau Streets? He was led to a seat beside a small table, upon which had been placed the first telegraph register ever used, and which had been connected for the occasion with every telegraph wire in America, as well as with those in foreign lands. He had but to lay his finger on the key to speak to a listening world. There was a moment's impressive silence. Then the click, click, of the instrument was heard in the farewell message of the father of the telegraph.

"Greeting and thanks to the telegraph fraternity throughout the world. Glory to God in the highest, on earth peace, goodwill toward men.

"S. F. B. MORSE."

From the four corners of the globe came back the answers, each a blessing upon the man who had made all the peoples of the round earth to be as one.

Once more he came before the public. It was fitting that he, before all others, should unveil the statue to Benjamin Franklin, in Printing House Square, New York. It was a bitter cold day. When his venerable form appeared before the multitude, his long white hair blown about by the winter's wind, cheers rent the air. That exposure cost him his life. A few months after, he was saying to his pastor from a bed of agonising pain—

"Doctor, the best is yet to come."

His last words were in reply to his physician, who tapped upon his breast, saying—

"This is the way we doctors telegraph, Professor."

"Very good, very good," was the cheery response, the smile with which he said it illuminating his face when all was over.

He died on the 2nd of April, 1872, aged eighty-one years, and his remains were laid to rest in Green-wood Cemetery.

Like Franklin, Morse was gifted with the spirit of observation and discovery, and that "passionate patience," which is but another name for genius. Unlike Franklin, the spiritual in his nature grew in proportion with the scientific element, and was the inevitable consequence of his faith in Him whom he believed had chosen him as the one through whom a great gift was to be given to humanity—an instrument for the salvation of men. If one was the representative philosophical mind of the American

people, let Christianity rejoice in the full fruit its gospel hath borne in Samuel Finley Breese Morse. "I feel I am doing a great work for God's glory, as well as man's welfare," were the words so characteristic of his sincerest conviction. Thrcugh him "what hath God wrought?"

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